

New Scientist

WEEKLY 11 December 2021

HOW TO BE RATIONAL
Steven Pinker on embracing
your smartest self

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THE AMAZON**
What can be done to
pull things back?

A DIFFERENT KIND OF GPS
Find your way by cosmic rays

A NEW EYE ON THE UNIVERSE

How the world's most powerful
telescope is about to rewrite the
story of the cosmos

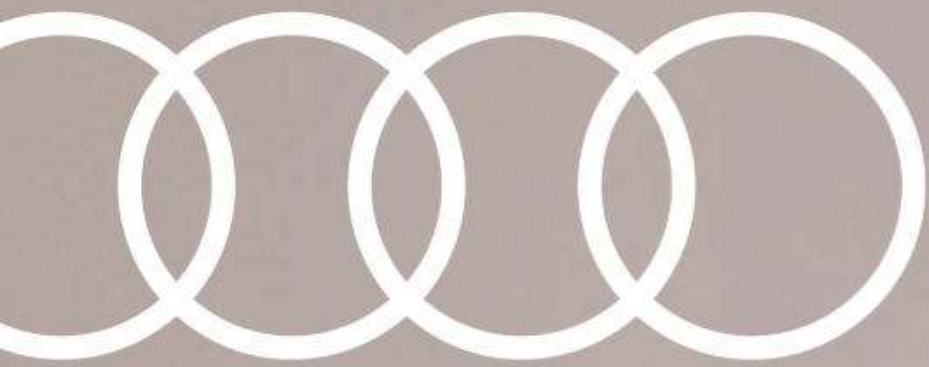
NEXT WAVE

What can we expect from omicron?

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Virtual reality (VR) technology is advancing apace and some shared VR worlds could be the next phase of the internet. In this talk, philosopher David Chalmers draws on science and philosophy to argue that virtual worlds need not be fake. Instead, he says, they can be genuine, meaningful realities. Join us on 10 February from 6pm GMT (1pm EST).

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Online

Covid-19 daily briefing

Stay up to date with the most crucial developments in the pandemic with our briefing, updated every weekday. We round up all the latest news, plus give links to exclusive interviews and features.

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coronavirus-latest](https://newscientist.com/coronavirus-latest)

Podcast

Weekly

Omicron, the new covid-19 variant, has become dominant in South Africa and is spreading fast. The team examines fears that this version of the coronavirus may be more transmissible than the delta variant and better at evading vaccines and immunity. Plus: research on 5000-year-old jars shows that ancient Egyptians used to eat alcoholic porridge – yes, seriously! And there is new evidence suggesting that water may have first arrived on Earth like rain from space.

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Another reality Why virtual worlds could be more than just fiction

Newsletter



COLIN BLACK/LAMMY

No more beef Calls grow for cattle pasture to make way for forests

Video

Rise of the xenobots

A team of researchers has developed "robots" made from the skin cells of *Xenopus laevis* frogs. Watch how they move, gathering up mounds of other cells that then turn into new robots. It is a strange new form of reproduction. Don't forget to subscribe to our channel for more incredible discoveries and explainers.

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Newsletter

Fix the planet

Get Adam Vaughan's newsletter about the climate emergency delivered for free to your inbox every week. In the latest edition, he talks to an entrepreneur who thinks livestock farmers could be better off ditching animals and planting trees on their land, even if the price of carbon were just £38 per tonne.

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Newsletter

“Could livestock farmers make more money by planting trees instead?”



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ATEM Mini Pro model shown.

Introducing ATEM Mini Pro

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Create Training and Educational Videos

ATEM Mini's includes everything you need. All the buttons are positioned on the front panel so it's very easy to learn. There are 4 HDMI video inputs for connecting cameras and computers, plus a USB output that looks like a webcam so you can connect to Zoom or Skype. ATEM Software Control for Mac and PC is also included, which allows access to more advanced "broadcast" features!

Use Professional Video Effects

ATEM Mini is really a professional broadcast switcher used by television stations. This means it has professional effects such as a DVE for picture in picture effects commonly used for commentating over a computer slide show. There are titles for presenter names, wipe effects for transitioning between sources and a green screen keyer for replacing backgrounds with graphics.

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The ATEM Mini Pro model has a built in hardware streaming engine for live streaming via its ethernet connection. This means you can live stream to YouTube, Facebook and Teams in much better quality and with perfectly smooth motion. You can even connect a hard disk or flash storage to the USB connection and record your stream for upload later!

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With so many cameras, computers and effects, things can get busy fast! The ATEM Mini Pro model features a "multiview" that lets you see all cameras, titles and program, plus streaming and recording status all on a single TV or monitor. There are even tally indicators to show when a camera is on air! Only ATEM Mini is a true professional television studio in a small compact design!

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Better late than never?

The James Webb Space Telescope has come at great expense, but it should be worth it

THEY say good things come to those who wait. And when it comes to the James Webb Space Telescope (JWST), we have been waiting long enough. Originally due to launch in 2007, it has been plagued by delays due to engineering problems, the need to find money to meet its soaring costs and, more recently, the covid-19 pandemic. It has now racked up a bill around 20 times its initial budget.

Finally set to blast off in a few weeks, this extraordinary machine promises to show us the moment the first stars lit up and solve all manner of cosmic mysteries (see page 36). But given all the effort and the eye-watering expense, will it be worth it?

We could compare the project to another feat of engineering, the Large Hadron Collider (LHC). Like the JWST, the LHC was first conceived in the mid-1990s.

It would be a vast underground ring of magnets designed to accelerate and smash particles together to reveal the secrets of the quantum world. It was also late: it was meant to be finished in 2005, but was first switched on in 2008 – and it cost more than \$5 billion to build.

Despite all that, the LHC is clearly a

“To put the telescope’s price tag in perspective: it is less than the latest US aircraft carrier”

success story, revealing the existence of the Higgs boson, a particle that confers mass on all others, along with additional insights that have given us invaluable clues to the very nature of reality.

The promise of the JWST is just as great. But it is far later than the LHC and twice

as expensive. Even if the telescope does deliver on its promises, we shouldn’t simply shrug off the expense of such projects in the name of science. In future, we need to find ways to manage epic projects better – and manage expectations. For starters, we should be more realistic about costs from the get-go. However, we should also see the JWST’s price tag in perspective: it is a few billion dollars less than the most advanced US aircraft carrier.

Ultimately, the telescope’s success rests on the risky next phase of the mission. A few days before Christmas, engineers plan to strap it inside a rocket, fire the engines and send it on a long journey into space. For those astronomers watching with bated breath, a safe launch would be the most long-awaited – and expensive – Christmas present they could wish for. ■

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Email tca-articlesales@tribpub.com

Subscriptions

newscientist.com/subscription

One year print subscription (51 issues) UK £198

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Share Price	35.1%	0.3%	-2.8%	52.8%	9.7%
MSCI China Index	37.2%	-0.6%	1.1%	24.9%	-7.7%
Past performance is not a reliable indicator of future returns. Source: Morningstar as at 31.08.2021, bid-bid, net income reinvested. ©2021 Morningstar Inc. All rights reserved. The MSCI China Index is a comparative index of the investment trust.					

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Dark web certificates

Proof of covid-19 vaccination for sale on dark web **p8**

Secret camera scan

Using smartphones to detect hidden lenses **p9**

Mystery hominin

Bear footprints turn out to be from an ancient human **p12**

DeepMind maths

Artificial intelligence helps to develop a new conjecture **p16**

Short not stunted

A small stature isn't usually a sign of malnutrition **p19**



JEROME DELAY/AP/SHUTTERSTOCK

A vaccination centre in Orange Farm, South Africa

already been several reports of superspreading events where an extraordinarily high proportion of people were infected at parties in Norway, Denmark and the UK.

The good news is that the expectation is that people infected despite vaccination or prior infection will still be less likely to become severely ill than those with no prior immunity, as with delta. This is because while omicron may be able to evade antibodies, it is much harder for it to escape immune cells called T-cells that help clear viral infections. We also have much better treatments now, though they are mainly available in high-income countries.

Because of the lag between people getting infected, becoming seriously ill and recovering or dying, it could still be many weeks before it becomes clear just how well vaccination or prior infection will protect against severe disease, and how badly omicron will affect those with no prior immunity.

During a press conference on 3 December, Waasila Jassat at the National Institute for Communicable Diseases in South Africa said the country has already seen a surge in hospitalisations in all age groups. Notably, children under 5 were the second biggest group after people aged over 60.

We will have to wait to see how those being hospitalised fare. One hospital in South Africa said that fewer covid-19 patients than normal were requiring oxygen as of 2 December, but cautioned that it is too early to draw conclusions.

Even if a smaller proportion of those who are infected with omicron become severely ill than was the case with previous variants, if it infects large numbers of people, hospitals could still be overwhelmed. ■

Covid-19

The omicron wave

The new variant seems to be highly transmissible and poised to cause a huge wave of infections worldwide, reports **Michael Le Page**

THERE is growing evidence that the new omicron variant of the coronavirus is capable of spreading rapidly in populations with immunity against other variants. A wave of infections around the world looks inevitable, but the big unknown is whether omicron is more or less likely to cause severe disease and deaths.

Aris Katzourakis at the University of Oxford says he doubts the variant's mutations will result in decreased severity, but that it is too early to tell. "We are all worried," he says. "We are waiting with bated breath."

In South Africa, where the variant was first detected, cases are rising even faster than during previous waves, with

numbers doubling every three to four days. But this doesn't necessarily reflect what will happen elsewhere. The beta variant that was first spotted in South Africa and caused its second wave didn't result in similar spikes in cases in other nations.

However, there are signs that omicron is already taking off in other countries. The UK is seeing a rapid rise in so-called S-gene dropouts in PCR covid-19 tests, a phenomenon that happens when a variant has certain mutations in the gene for its spike protein. This is likely to be due to omicron. Denmark, which does a lot of sequencing, has already detected more than 260 cases of covid-19 caused by this variant.

The main reason omicron is spreading so fast appears to be that it is excellent at evading prior immunity. Researchers in South Africa have found that the risk of reinfection is much higher with omicron than with other variants. This suggests that the risk of vaccinated people getting infected is also much greater than it is with the delta variant. Initial case reports back this up. For instance, of 11 omicron cases in Israel so far, six are in people who had received three doses of the Pfizer/BioNTech vaccine.

Besides potentially being able to evade immunity, omicron might also be inherently more transmissible than delta. This remains uncertain, but there have

Cosmic rays used for Arctic GPS

Muons made by cosmic rays can be used for navigation at latitudes where GPS works poorly

David Hambling

NAVIGATION via cosmic ray muons could supplement GPS in high latitudes, as well as working underwater and underground.

The US Office of Naval Research (ONR) has awarded a contract to UK company Geoptic Infrastructure Investigations to demonstrate navigation in the Arctic where GPS coverage is poor due to positioning of GPS satellites run by the US military, which are mostly at lower latitudes.

The firm's Muometric Positioning System (muPS) uses muons made by cosmic rays instead of the radio signals from satellites used by GPS. When a high-energy cosmic ray strikes the upper atmosphere, a shower of muons rains down. These pass through solid matter, but can be detected by scintillation counters. On average, "one muon will pass through your thumbnail every minute", says Chris Steer at Geoptic.

MuPS has a set of reference counters that pick up muon showers in a pre-defined locale. Aided by precise atomic clocks, they triangulate the source and time of each shower. This allows

a mobile counter to locate itself by comparing the time difference for the same shower.

The method requires multiple muon showers to get a fix on the location, but lab tests have shown how accurate it can be. Just 10 muon events are enough to locate a point with an accuracy of 60 millimetres, says Lee Thompson at Geoptic. Further measurements increase

An artist's representation of high-energy cosmic rays colliding with Earth



SCIENCE PHOTO LIBRARY/ALAMY

that to 10 millimetres or less.

The proof-of-principle experiment will use detectors that are 1 square metre in size, plus atomic clocks accurate to within a 10 billionth of a second. These cost tens of thousands of dollars, but are quickly becoming cheaper.

The real challenge is that the ONR wants a demonstration beneath the surface of a frozen lake in Finland to take place before August 2022. "The average temperature is around -20°C, so we'll be using [snowmobiles] for transport and cutting holes in the

ice with chainsaws to deploy the system," says Steer.

The aim is to show that muPS works in difficult field conditions. Once the receiver has been calibrated with the reference counters, it can continue to locate itself while underwater even if it only communicates with the counters intermittently.

MuPS could provide underwater navigation for uncrewed vehicles and submarines. Precise submarine navigation is a major issue: in October, the nuclear submarine USS Connecticut was damaged by a collision with an underwater mountain.

The developers say that because muons can also travel through rock, they have had interest from the US Army in a portable version for navigating tunnels.

"This is the first time I've heard of [cosmic rays] being used for navigation, but there are a lot of new applications ranging from mineral prospecting to inspecting industrial infrastructure and detecting nuclear material," says David Mahon at the University of Glasgow in the UK. ■

Cybercrime

Covid-19 vaccine passports for sale on the dark web

DIGITAL covid-19 vaccination certificates for use in the US and the European Union are available to buy on the dark web. Most appear to be fake, but others may be valid entries in national databases that have been leaked, say researchers.

Covid-19 restrictions in many countries require proof of vaccination against the coronavirus to access certain places, such as restaurants. Vaccine passports

most commonly take the form of a digital record in a smartphone app, presented as a scannable QR code.

Emmanouil Vasilomanolakis at Aalborg University in Denmark and his colleagues found 17 marketplaces and 10 shops on the dark web – a collection of websites that can be accessed privately via special browsers – that claim to offer falsified digital vaccine passports for sale. The researchers analysed listings using search engines that crawl the dark web.

The listings claimed to sell vaccine passports and certificates for a number of European countries

and the US in exchange for payment in cryptocurrencies. But many of the certificates aren't real, says Vasilomanolakis. "Our opinion, at least from our findings, suggests that the vast majority of everything is a scam," he says.

However, Vasilomanolakis and his colleagues believe there were a number of legitimate vaccination certificates offered for sale. Some of the QR codes shown as evidence

"Some of the QR codes to entice customers to buy appear to be valid entries in national databases"

to entice customers to buy appear to be valid entries in national databases. One seller displayed a video showing part of the back end of a European vaccine records system, indicating they had access to it (arxiv.org/abs/2111.12472).

The possibility that insiders might have leaked some certificates is concerning, says Matthew Shillito at the University of Liverpool, UK, who studies the dark web. "It appears some could be people within health service providers selling or providing access to legitimate certificates," he says. ■

Chris Stokel-Walker

Technology

Smartphone app detects hidden camera lenses

Matthew Sparkes

SURVEILLANCE cameras can keep us safe or invade our privacy, and improvements in miniaturisation mean they can now be hidden in almost any object. Now there is a smartphone app that helps users detect such hidden cameras.

Commercial devices to spot hidden cameras are available, but carrying a specific device for this purpose is inconvenient. Sriram Sami at the National University of Singapore and his colleagues hope to provide the same function via a standard smartphone.

Their system uses a time-of-flight sensor, which emits a beam of infrared light and measures how long it takes to be reflected from an object. The sensors have become increasingly common in smartphones and are used to improve the quality of photographs.

Sami and his team created a smartphone app that uses information from these sensors to spot the unique reflections from hidden cameras. The app detects any spots on the object where the incoming light is brighter, which indicates a reflective surface and potentially a camera lens. It uses machine learning techniques to separate innocuous results from suspicious ones.

The researchers recruited 379 people and showed them videos of 30 different objects recorded from less than a metre away. They had to identify if they saw any hidden cameras and mark the location of them. With the naked eye, the volunteers spotted the cameras 46 per cent of the time, whereas the AI tool had a success rate of 88.9 per cent (*SenSys '21*, doi.org/gnh87c).

“Users can trade off between catching more hidden cameras but dealing with more false positives and vice versa just by adjusting a slider,” says Sami. ■

Climate change

Fake-meat boss wants farms to swap livestock for trees

Adam Vaughan

THE founder of plant-based “meat” firm Impossible Foods is talking to UK farmers about a pilot project to swap livestock for trees to fight climate change.

Pat Brown, a scientist at Stanford University in California, set up the fast-growing company in 2011. He says he wants to demonstrate the economic benefits of taking farmland out of cattle and sheep production to allow forests to grow on it and absorb carbon. Brown argues that livestock farmers would be better off as a result by selling carbon offsetting permits to airlines and other polluting industries.

“It’s very nascent. What I’m interested in doing is kind of like a... demonstration project to show that it is actually very financially sound to buy land from livestock farmers and manage it for biomass recovery and sell carbon offsets,” Brown tells *New Scientist*.

He is one of a rising number of experts proposing that land for meat production will need to

be freed up to grow trees that suck carbon dioxide out of the atmosphere if the world is to meet its climate goals. The UK government’s statutory climate advisers want to see a fifth of farmland there turned over to grow trees to store carbon.

“Almost every livestock farmer on Earth would make more money at \$50 (£38) a tonne [of carbon dioxide], accumulating [plant] biomass on their land as opposed to livestock,” says Brown. The price of a tonne of CO₂ in the UK’s post-Brexit carbon trading scheme has been over £50 in recent months.

On a recent trip to the UK for the COP26 climate summit in Glasgow, Brown spoke to farmers about hosting a trial project. He says there was some scepticism, but he believes the wider adoption of the idea could be appealing because “those farmers are making a pittance right now”.

“I agree with the idea in principle,” says Pete Smith at the University of Aberdeen in the UK. “I can see why it is met with some scepticism though – livestock farmers are not

foresters. We need to find a way of transitioning away from livestock farming in a way that works for farmers.”

Brown says he was disappointed that speeding up the phase-out of animal agriculture to cut emissions wasn’t high on the agenda at COP26. “This should be the number one topic at COP, because there’s nothing that

20%

slice of farmland needed for tree-planting, say UK advisers

comes close for having a fast and dramatic impact on climate change,” he says.

A recent paper by Brown, not yet peer-reviewed but accepted for publication, calculates that phasing out animal agriculture in 15 years and allowing trees and other plants to grow on the land involved would provide around half the emissions savings needed to meet the Paris Agreement’s goal of holding temperatures below 2°C this century. Previous studies came to similar conclusions.

The UK’s National Farmers’ Union (NFU) says carbon markets hold potential opportunities for farmers. But Stuart Roberts at the NFU says: “We really must move away from the idea that all livestock production is the same the world over and by simply removing it from the equation we solve the climate change crisis overnight. This simply isn’t the case.”

A spokesperson for Impossible Foods says: “We continue to explore new ways to work with farmers to support initiatives that provide the best value for their land.” ■



ROBYN BECK/AFP VIA GETTY IMAGES

Proposed anti-trolling law could be used to silence critics of the Australian government

Efforts to stop anonymous trolls are unlikely to work, but could see more people sued for defamation, says **Alice Klein**

AUSTRALIA'S prime minister Scott Morrison has said that "anonymous trolls are on notice". His government released draft legislation on 1 December designed to force social media companies to expose the identities of anonymous users who post defamatory comments.

"These will be some of the strongest powers to tackle online trolls in the world," Morrison said when announcing the proposed law. But experts say the legislation is political theatre because it won't do anything to stop most forms of online bullying (see page 25). Instead, it could undermine individuals' privacy and fuel the current trend of government MPs suing their social media critics.

If the proposed Social Media (Anti-Trolling) Bill is passed, it will allow Australians who feel they

"This proposed law is political theatre, designed to frame ministers suing citizens as justified"

have been defamed on social media to request court orders forcing providers to disclose the real names, country locations, phone numbers and email addresses of users who have allegedly defamed them. The idea is to unmask trolls who have been hiding behind anonymous user names so that legal action can be launched against them, as long as they are also in Australia.

If the social media company can't comply, because it doesn't know the real identity of the accused user, or it refuses to comply, it will be held liable for the defamatory comments.

This is a major problem, because many people set up accounts with fake details, says Jennifer Beckett at the University of Melbourne in Australia. Requiring users to verify



OLIVIER DOULIER/AP VIA GETTY IMAGES

their identities with ID would mean handing over private information, she says.

The proposed law wouldn't even deter most kinds of online trolling, because only a small portion of it actually constitutes defamation, says Beckett. To be considered defamatory, a comment must be shown to harm someone's reputation. Most online bullying involves insults like calling people "fat" or "ugly", which are upsetting but not against the law in Australia.

Many social media users who go by their real names still insult others on a regular basis, so the threat of losing anonymity isn't going to change their behaviour, says Beckett. But government figures who have the wealth and

resources to launch defamation cases may benefit, she says.

For example, defence minister Peter Dutton won a defamation case against refugee advocate Shane Bazzi on 23 November. Bazzi was ordered to pay Dutton A\$35,000 (US\$25,000) for tweeting that he was a "rape apologist". In March, Dutton told a radio station that he wanted to sue more social media users, including those with anonymous accounts. "Some of these people who are trending on Twitter or have the anonymity of different Twitter accounts, they're out there putting out all these statements and tweets that are frankly defamatory," he said. "I'm going to start to pick out some of them to sue."

Other recent cases include government MP Andrew Laming launching legal action against Louise Milligan, a journalist at the ABC, Australia's national broadcaster. She later agreed to pay Laming A\$79,000 in a defamation settlement. Government MP Anne Webster also sued a Facebook user for defamation, winning A\$875,000 and New South Wales state MP John Barilaro sued a YouTuber, who settled out of court.

Michael Douglas at the University of Western Australia

Social media firms could become liable for defamatory comments

says the proposed anti-trolling law could facilitate more defamation cases against ordinary Australians. "This proposed law is political theatre, designed to frame government ministers suing regular citizens as somehow morally justified as a 'fight against trolls'," he says. "I would not be surprised if we see more and more cases of politicians suing."

Legal powers

In 2018, the Morrison government introduced another law targeted at tech companies that was meant to keep Australians safe from terrorism and organised crime but has since been used to investigate journalists. The Assistance and Access Act can be used to force secure messaging services like WhatsApp to help police access metadata and encrypted communications. It was used in Australia's biggest-ever crime bust in June – which led to more than 300 people being charged – but has also been used to investigate ABC reporters after they published allegations of Australian war crimes in Afghanistan.

"[The government have] used these powers against serious criminals, but they also haven't hesitated to use them against journalists," says Vanessa Teague at the Australian National University. "This agenda has a serious negative impact on the capacity of Australians to communicate freely and securely."

The proposed Social Media (Anti-Trolling) Bill will now be opened for public consultation so stakeholders can provide feedback before it is formally introduced to the Australian parliament. ■

Australian prime minister Scott Morrison



MICK TSIKAS/EPAP-EPF/SHUTTERSTOCK

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Human evolution

Fossil footprints hint at mystery hominin with unusual walking style

Michael Marshall

ANCIENT footprints that were once thought to have been made by a bear walking on its hind legs were actually made by an extinct human species. The discovery means there are now three known sets of hominin footprints from the same locale in Tanzania.

It isn't clear which hominin species made the prints. The authors of the new study say they don't match the other sets of footprints at the site in Tanzania – called Laetoli – so were probably made by a different species. If this is true, it would mean that two hominin species coexisted in the same region at the same time.

"Not only are they not a bear, they are hominin and they are not the same hominin as those that made [the other footprints]," says Ellison McNutt at Ohio University Heritage College of Osteopathic Medicine in Athens.

The five footprints were discovered at Laetoli's "site A" in 1976. The tracks had been left in soft volcanic ash that subsequently hardened into rock. They were initially thought to have been left by a hominin, but later



JOHN READER/SCIENCE PHOTO LIBRARY

A footprint left by a hominin 3.66 million years ago

studies suggested that they were actually made by a bear walking on its hind legs. As a result, site A fell into obscurity.

Meanwhile, more footprints were found at "site G" in Laetoli, a few kilometres away. These were definitely made by hominins. The trail stretches 24 metres and includes prints (one of which is pictured above) from three individuals walking together. Both

sets of footprints are 3.66 million years old and are thought to have been made by *Australopithecus afarensis*, the species to which the famous Lucy fossil belonged.

Now, McNutt and her colleagues have re-excavated the footprints at site A. "The bear hypothesis was very reasonable at the time," she says, because the prints do look unusual. But the sediment in them was never properly cleaned out, so their true shape wasn't known. McNutt's team cleaned the prints thoroughly and produced 3D scans of them.

The researchers compared the tracks from site A with footprints made by humans, chimpanzees and American black bears. "There are a lot of things that make it distinctly hominin," says McNutt. For example, the big toes were proportionally much larger than the second toes, which is seen in hominins but not in bears (*Nature*, doi.org/g775).

The team was "very clever" to re-excavate site A, says Marco Cherin at the University of Perugia in Italy. "I think it almost definitely is a hominin."

McNutt and her colleagues also argue that the prints don't match the more famous tracks at site G, so were therefore made by a different hominin. For instance, the hominin seems to have cross-stepped, meaning it brought its feet across its body's central line, a gait seen in its most exaggerated form when fashion models walk

5

footprints were left by a mysterious hominin at a site in Tanzania

down runways placing one foot directly in front of the other.

"It's not *afarensis*," says McNutt. "It is certainly *Australopithecus* or something very like it."

She adds that elsewhere in Africa, there is clear evidence of multiple hominin species coexisting in the same regions, so it wouldn't be surprising if the same was true at Laetoli.

Cherin isn't convinced about that. "For the moment, I would be most cautious about the possibility of having two hominins in Laetoli," he says. ■

Astrophysics

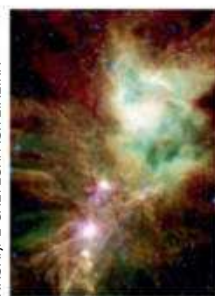
New look at infant suns may solve galactic mystery

POWERFUL outbursts of energy from young sun-like stars could be central to how they and their planetary systems form, according to a modelling study. The results hint at a possible explanation for a decades-old astrophysical mystery.

One idea for how stars like our own are born – the steady-state concept – makes predictions about how bright young stars should be when they are under construction,

continuously gathering gas and dust. Yet when we look into the Milky Way, these objects aren't anywhere near that bright and don't appear to grow quickly enough. This is called the luminosity problem.

A competing idea examined in the new research – the outburst model – suggests that nascent suns brighten dramatically during flurries of feeding as they accumulate, or accrete, material. "Outbursts solve the luminosity problem by providing episodes of much higher accretion," says Jason Steffen at the University of Nevada, Las Vegas, one of the researchers behind the work.



NASA/JPL-CALTECH/SPS/TEXEIRA

A star-forming cloud captured by NASA's Spitzer Space Telescope

Because this type of episode is transitory, that would help explain why we don't see young stars blazing brightly all the time.

As part of the study, the team modelled the physical properties and composition of a disc of material around a young sun that

had undergone outbursts. This tallied better with observations than the steady-state theory. For example, the outburst model more closely replicated the mix of ingredients measured in primitive meteorites from our solar system, known as carbonaceous chondrites (arxiv.org/abs/2111.03798).

The team also suggests that heating from outbursts by the infant sun could shed light on the origins of features in some meteorites called calcium-aluminium-rich inclusions, which appear to have been forged at high temperatures. ■

Will Gater



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Nornickel, the world's largest producer of palladium and high-grade nickel and a major producer of platinum and copper, announces the start of the Palladium Challenge, a contest with a USD 350,000 prize fund organised in partnership with the International Precious Metals Institute (IPMI).

The Palladium Challenge is an initiative intended to inspire individuals, businesses and academic institutions to invent and design a sustainable use-case that features and increases the demand for palladium. The metal is known for its catalytic capabilities and unique physical properties, and while it is widely used in the automotive industry as an essential component of catalytic conversion, the Palladium Challenge seeks to broaden its applications and spark innovation.

The Palladium Challenge will be judged by an independent panel of global experts who will review all submissions.

The **top three projects** will receive global recognition and **will be awarded monetary prizes on September 16, 2022** at the IPMI Annual Platinum Dinner in New York City.

Covid-19

UK lags on child vaccinations

As concerns over long covid and the omicron variant grow, why has the UK been relatively slow to vaccinate young people? **Clare Wilson** reports

FOR the first few months of this year, the UK led most other countries in vaccinating as many people against covid-19 as quickly as possible. But the nation has been one of the slowest high-income countries to vaccinate teenagers. News of the omicron variant of the coronavirus prompted the UK to recommend that 12 to 15-year-olds can now have a second vaccine dose three months after their first, but 5 to 11-year-olds remain totally unvaccinated. What is behind the UK's apparent reticence around giving children jabs?

While the UK was a pioneer in its efforts to vaccinate older adults – it was the first high-income nation to approve any covid-19 vaccine – when it comes to children, it is

“12 to 15-year-olds can now have a second dose, but 5 to 11-year-olds are totally unvaccinated”

being much slower. The country's Medicines and Healthcare products Regulatory Agency (MHRA) extended legal approval for use of the Pfizer/BioNTech jab to children aged 12 and over in June, in line with many other countries. Places such as the US and Israel actually started vaccinating this age group in May and June, respectively.

Estimating long covid

However, the UK body that decides on vaccine deployment, the Joint Committee on Vaccination and Immunisation (JCVI), took until September to conclude that the benefits of the jab for healthy 12 to 15-year-olds “are marginally greater than the potential known harms... [but] the margin of benefit... [is] too small to support advice on a universal

MATTHEW HORWOOD/GETTY IMAGES



Children at a school in Cardiff, UK, in September



A vial of the Pfizer/BioNTech vaccine

programme of vaccination”.

The JCVI said the benefits of vaccination are smaller for children because they are less likely to get seriously ill from covid-19 and the jab carries the risk of the rare side effect of myocarditis, or heart inflammation. Regarding long covid, something that worries many parents, the committee said in August that estimates of symptoms lasting more than eight weeks in children ranged from less than 1 per cent to 10 per cent of cases – with more rigorous studies “generally reporting rates at the lower end of this range”.

There has certainly been a wide range of estimates for the prevalence of long covid, partly because there is no widely agreed definition of it: while the core

symptoms include problems such as fatigue and headaches, one study linked the condition with more than 200 symptoms. “The problem is long covid has not been defined in children,” says Michael Absoud at King's College London.

Initial research also tended to overstate the condition's prevalence by failing to use a comparator group of children who had never caught covid-19, because it is common for teenagers to report symptoms such as fatigue, for instance. In August, a study in England that did use a non-infected comparison group found that 30 per cent of 11 to 17-year-olds who had covid-19 reported three or more symptoms three months later, compared with 16 per cent of those who hadn't been infected. This translates to

DAVID ZALUBOWSKI/PI/SHUTTERSTOCK



about 14 per cent of people in the age group experiencing persistent covid-19 symptoms, higher than the JCVI's estimate range.

However, the figure could have been inflated by the fact that only 13 per cent of families who were contacted took part in the study, with those whose children were ill being more likely to do so. One large ongoing survey by the UK Office for National Statistics (ONS)

issues not in the committee's remit, such as the benefits of teenage vaccination in reducing transmission to adults, and in the children themselves missing less school. Only in mid-September, after the school year had begun, did the CMOs give the go-ahead for 12 to 15-year-olds to have a first vaccine dose.

By this point, countries such as Spain, France and Denmark had already given most teenagers their first jab. "A lot of countries have stormed ahead with vaccinating children," says Simon Williams at Swansea University, UK. "It's unsurprising the public are puzzled [in the UK]."

A slow roll-out coupled with many schools dropping mitigation measures like mask wearing led to a surge of infections in UK schools, which spread to other age groups. At the peak in mid-October, 3.2 per cent of children in state schools in England were absent due to covid-19 and hospital admissions among 5 to 14-year-olds in England were nearly double the rate they had been during the UK's second wave in January, at about 1.8 per 100,000 children of that age group. The coronavirus was

"Even lower estimates suggest thousands of kids could be developing long covid a week"

puts the prevalence of persistent symptoms among 12 to 16-year-olds much lower, at 3 per cent up to four months after a positive covid-19 test, compared with 1.3 per cent in an uninfected control group. "Even if it's at the lower end of the estimates, with the number of infections we're seeing, that's still thousands of kids a week," says Stephen Griffin at the University of Leeds, UK. "That's really worrying for me."

Slow roll-out

It is hard to evaluate the JCVI's decision-making, however, because the committee has yet to publish a detailed breakdown of its analysis – just some brief figures on expected benefits and risks of vaccination that don't mention long covid. "It's very difficult to understand how they reached their conclusions," says Griffin.

In September, the JCVI handed over the decision on vaccinating children to the chief medical officers (CMOs) of the UK nations, because they could weigh up other

A 16-year-old gets vaccinated in London in August

ANNA WATSON/LAMY LIVE NEWS



3.2%
of state school children in England were absent due to covid-19 in mid-October

12
deaths in under-15s in England involved covid-19 in September and October

14%
of 11 to 17-year-olds may be experiencing long covid three months after infection

involved in 12 deaths of under-15s in England over September and October, according to ONS figures.

Russell Viner, a former president of the UK's Royal College of Paediatrics and Child Health, says that while he agrees with the JCVI's caution, the delivery of vaccines to teens should have happened faster. "Once the decision was made, we didn't cover ourselves with glory," he says.

Another vaccine tussle?

Daily covid-19 infections in the UK have been rising again since early November, and it is unclear what will happen to infection rates this winter, especially if the omicron variant starts circulating widely.

The next tussle is likely to be over the low-dose Pfizer/BioNTech vaccine for 5 to 11-year-olds, which was first offered to children in the US and Israel last month. A trial published in November shows that it cuts infections by 91 per cent.

This vaccine is under review by the MHRA. But if it gets approved, the initial signs are that, as happened with teenagers, the UK will be in no rush to use it. A spokesperson for the JCVI didn't respond to *New Scientist's* questions in detail, but did say the committee "has consistently maintained that the main focus should be the benefits to children themselves, balanced against any potential harms to them from vaccination. It is not within the JCVI's remit to consider the wider societal impacts of vaccination."

"I think there's going to be a bit of a delayed process in the UK this time round too," says Williams of the low-dose vaccine. "There are signs that history may repeat itself."

"It's not an easy call," says Absoud. "I don't envy anyone making decisions in a pandemic." ■

AI collaborates with mathematicians

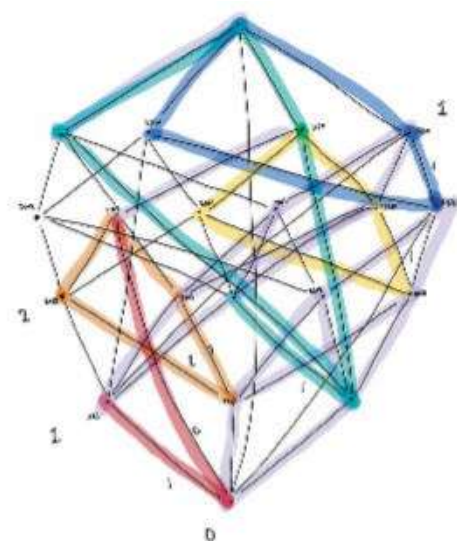
DeepMind's AI software has helped humans develop a new mathematical theorem

Matthew Sparkes

MATHEMATICIANS searching for a theorem about the structure of knots have been helped in their work by AI software, but the suggestions given by the code were so unintuitive that they were initially dismissed. Only later were they discovered to offer invaluable insight. The work suggests AI may reveal new areas of mathematics where large data sets make problems too complex to be comprehended by humans.

Mathematicians have long used computers to carry out the brute force work of large calculations, and AI has even been used to disprove mathematical conjectures. But creating a conjecture from scratch is a far more complex and nuanced problem that requires intuition, skill and the stringing together of lots of logical steps.

UK-based AI company DeepMind, owned by Google's parent company Alphabet, has previously had success in using AI to beat humans at games of chess and Go. Now the firm's scientists have shown that AI can provide



One of the mathematical objects that DeepMind's AI examined

human mathematicians with leads to develop theorems.

Unlike most neural network research, in which an AI is fed large amounts of examples and learns to create similar inputs, the AI here examined existing mathematical constructs for patterns that could guide human mathematicians towards new discoveries.

Marc Lackenby and András Juhász at the University of Oxford worked with DeepMind to create a new theorem relating to knot theory. Knot theory is the study of knots as found in rope, except that in these models the two ends are joined together. Although the field does provide insights into how a rope can tangle, it also has applications in quantum field theory and non-Euclidean geometry.

DeepMind's AI software was given details of the two previously separate components of knot theory – algebraic and geometric – and asked to seek any correlations between them, both straightforward correlations and also unintuitive ones. The most interesting of these leads were passed to human mathematicians for analysis and refinement.

Lackenby says that the AI identified a string of variables that hinted at a correlation between the two previously distinct fields. Initially, the team took only the three strongest of these suggested variables and

tried to work on a conjecture.

"We spent quite a long time trying to prove that, and it turns out not to be quite correct," says Lackenby. "But the fourth and the fifth [AI suggestions], in this very subtle way, also control the

"We were working in a world where our intuitions were being challenged. I was very, very surprised"

signature. So actually, we would have saved ourselves quite a bit of time if we had taken what the machine learning was telling us at face value."

Once those additional variables were taken into account, the team was able to complete the conjecture and also prove the theorem (*Nature*, doi.org/gnns5p).

"We were working in a world where our intuitions were being challenged," says Lackenby. "We didn't expect there to be such a clear relationship between these algebraic and geometric quantities, so I was very, very surprised." ■

Climate change

UK refuses to release document showing net-zero savings

THE UK government has refused a freedom of information request to release figures showing how much its Net Zero Strategy will cut carbon emissions for individual measures.

Withholding the document smacks of "secrecy and subterfuge" and prevents the public from interrogating the estimated impacts of the measures, says Ed Matthew at climate change think tank E3G.

The Net Zero Strategy published on 19 October lays out how the UK

plans to reach its commitment to hit net-zero greenhouse gas emissions by 2050 in the coming years.

Previous government blueprints for decarbonisation have estimated exactly how much individual policies will cut emissions.

Government officials conceded that there is a spreadsheet containing all the figures, but said they wouldn't release it. Now, the Department for Business, Energy and Industrial Strategy (BEIS) has refused a freedom of information request by *New Scientist* to publish the document, on the grounds that it involves the disclosure of internal communications. Public interest

doesn't outweigh the need to keep such communications private, says the BEIS FOI team.

The UK is off-track for its legally binding carbon targets for the 2020s and 2030s, a trajectory that the strategy claims it will rectify. But it doesn't provide enough detail to independently judge that, says Matthew. "They can't be in charge of marking their own homework and need to make their calculations public immediately," he says.

2050

Year by which the UK aims to achieve net-zero emissions

The strategy doesn't break down the emissions from individual measures, such as backing new hydrogen production, which will be supported by hundreds of millions of pounds in public funding.

"Ministers are behaving like a shady dealer asking customers to buy a product without seeing it first," says John Sauven at Greenpeace UK. A BEIS spokesperson said: "There is nothing secretive about the UK's Net Zero Strategy, the first of its kind from any major economy." *New Scientist* has appealed the decision not to publish the document. ■

Adam Vaughan

AFGHAN CRISIS APPEAL



'We're treating malnourished children and their number is increasing...'



MARIA FIX
MSF NURSE,
AFGHANISTAN

"At the moment, we are the only

major hospital in the region that is functioning. There are around 1.5 million people living in Helmand province and the health system across the region has essentially collapsed.

Our hospital is super-congested and we're incredibly busy. We have 300 beds, but at times recently we've had between 330 and 350 patients. That means a lot of juggling and making do, with children sharing beds. It's not ideal, but otherwise we wouldn't be able to treat all the patients coming to us.

Our paediatric department is overwhelmed. We're treating a lot of malnourished children and their number is increasing.

Even before the change of government, around half of the population relied for food support on aid organisations, but now a lot of that support has collapsed and many children are going hungry.

I don't think you ever get used to seeing malnourished children. Often they arrive dehydrated and in shock. We work to stabilise them in the emergency room before moving them to intensive care and then to the inpatient therapeutic feeding centre, where we feed them and slowly build up their strength.

It's very moving to see a child who has been so sick and malnourished recover and come back to life. But it's challenging at the same time, particularly when you know that, even if we stabilise them here and they recover, they're going to face the same problems – the same lack of food – as soon as we discharge them. But we do what we can and it's important that we do.

It's so important that MSF is here. When I was preparing to travel to Afghanistan at the end of August, people asked me why I was going there just as everybody else was leaving. When you're here, it does feel like Afghanistan has been abandoned – so many international organisations

have left. But I'm so happy and proud that MSF has stayed. The people here are suffering and it's vital for us to be here, providing medical care to people who so desperately need it."

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Above: An MSF doctor checks on a premature baby in the neonatal unit of MSF's maternity hospital in Khost, 18 October 2021. Photograph © Oriane Zerah

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Ecology

Web of life in icy lakes faces turmoil in a warming world

Brian Owens

THE timing of when ice forms on lakes in the winter can have big knock-on effects on life in the water the next spring and summer.

As the climate warms, lake ice is forming later and thawing earlier. But not much research has been done on what happens in lakes during the winter, partly because the ice-covered period has long been considered a dormant season for freshwater organisms.

"This is rather alarming given that we do not know much about under-ice lake ecology, so it is even harder to anticipate the consequences of ice loss and predict future changes," says Marie-Pier Hébert, an aquatic scientist at McGill University in Montreal, Canada.

To find out more, Hébert and her colleagues conducted a unique experiment to manipulate the timing of ice onset in a lake in Canada. They constructed a floating platform with several deep containers extending below it, essentially turning columns of water into giant test tubes. Then, once the lake froze, they broke up and melted the ice in each container twice a day at dawn and dusk, delaying the onset of winter ice cover for 8, 15 or 21 days.

This had a profound effect on life in the water below. A later freeze meant that algae could continue photosynthesis for longer, which allowed some of the tiny zooplankton that feed on the algae to fatten up more and so survive throughout the winter under the ice. Those surviving zooplankton then got a head start on eating the new batch of spring algae once the ice started to melt, leaving less food available for species that only become active once the ice is gone (*PNAS*, doi.org/g78g).

These changes in the population of algae and zooplankton could cascade through the food web, says Hébert. ■

Physiology

Humans were relatively short for thousands of years

Michael Marshall

FOR most of our history, humans have been short, a study has found. Until around 150 years ago, few people grew taller than 170 centimetres – not even the most privileged individuals, who had ready access to food.

The discovery adds to growing evidence that stunting – being unusually short – isn't a wholly reliable indicator of malnutrition. Instead of being a sign of a good diet, growing taller may instead reflect competition for dominance in some societies.

Christiane Scheffler at the University of Potsdam and paediatrician Michael Hermanussen in Altenhof, both in Germany, have spent several years studying the height of people from a wide range of populations. In their latest paper, they combined an existing data set of more than 6000 prehistoric human skeletons with multiple studies

of more recent historical populations from Europe and the US. They also included their own data on 1666 present-day schoolchildren from Indonesia.

In the prehistoric populations, the maximum height for men was 165 to 170 centimetres, while women topped out at 160 cm. Today, by comparison, men in England have an average height of around 175 cm, while for women it is about 162 cm.

170 cm

Maximum height discovered in prehistoric humans

The average heights of men and women are several centimetres higher in Germany.

The pair found that similar patterns to the prehistoric heights held in the historical populations. Even a group of upper-class German boys from the late 1800s were all much shorter than modern children, so much so that over half of them would be considered stunted by modern standards.

But there is significant

variation between modern countries. The Indonesian schoolchildren in the study were shorter than similarly aged children from the US, despite being well-nourished (*American Journal of Human Biology*, doi.org/g75k).

If food availability isn't the key to height, what is? Scheffler and Hermanussen argue that height can be a signal of dominance, so in societies where it is possible to move up through the social classes, evolution favours individuals who reach a greater height. Growing tall, says Scheffler, "is more or less associated with the hope of a better life".

S. V. Subramanian at Harvard University isn't convinced by the pair's interpretation. His team previously showed that the best predictor of a child's height is the height of their parents, indicating that the trait is highly heritable. This suggests that the influence of other factors, such as social mobility, is limited.

Scheffler also argues that stunting is a poor indicator of whether a child is malnourished. "We don't find any association between signs of nutritional status and height," she says.

Subramanian agrees that stunting isn't a perfect indicator of malnutrition. After assessing nearly 163,000 children living in 55 low and middle-income countries, his team found that 42.9 per cent had poor nutrition but no sign of stunting or other physical indicators of this fact.

This implies there is a lot of hidden malnutrition that doesn't reveal itself through stunting. A person's nutritional status should be assessed by looking at their diet not their height, says Subramanian. ■



WERA RODSAWANG/GETTY IMAGES



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Animal behaviour

Dolphins invent spin-diving method to swim deeper

A SPECIES of dolphin dives fast enough to catch prey hundreds of metres below the surface by twisting through the water at high speed.

Risso's dolphins exhale then dive down, twisting as they "drill" through the water. The technique quickly gets them to a dense layer of squid, fish and crustaceans with optimal use of energy and oxygen, says Fleur Visser at the University of Amsterdam in the Netherlands.

"They are air-breathing mammals, so it's costly for them to dive deep," says Visser.

She and her colleagues attached biologgers to seven Risso's dolphins (*Grampus griseus*) in the North Atlantic Ocean to record information about their sound, movement and depth. This provided data on about 226 dives ranging in depth from 20 to 623 metres.

For deep dives, the dolphins jerked their fins to rotate their bodies and exhaled hard, probably to reduce buoyancy. They then turned downwards at about 60 degrees and entered a fast, twisting descent followed by a rotating, gliding phase, achieving an average speed of 9 kilometres per hour and an average depth of 426 metres.

They didn't echolocate to find prey in the dark water until they had stopped spinning – after about 36 seconds on average. The dolphins then stayed underwater for nearly 10 minutes (*Royal Society Open Science*, doi.org/g78c).

The shallower dives didn't involve any twisting or turning. This means the dolphins knew where they were going, and what type of dive they needed to get there, says Visser.

Christa Lesté-Lasserre



JUDITH SCOTT/LAMY

Palaeontology

Armoured dinosaur had a fern-like tail

A NEW species of ankylosaur found in Chile had a unique tail unseen in any other member of this dinosaur family. The discovery sheds light on the mysterious origins of ankylosaurs in the southern hemisphere.

Ankylosaurs were quadrupedal, herbivorous dinosaurs that roamed Earth in the Jurassic and Cretaceous periods. Their skin was covered in bony deposits called osteoderms that protected them, much like a turtle's shell.

Alexander Vargas at the University of Chile in Santiago and his colleagues have reported the discovery of a new ankylosaur, whose almost-complete skeleton was found in the Río de Las Chinas valley in southern Chile. The team called the new species *Stegouros elengassen*.

The skeleton had a mix of traits from known ankylosaurs and

from stegosaurs, a related group of four-legged plant-eating dinosaurs. In fact, the pelvis of *S. elengassen* was almost identical to that of a stegosaur, but the jawbones that carried its upper tooth row look ankylosaurian.

The skeleton had a flat, weapon-like tail, with seven pairs of broad, laterally facing blades, making the tail end look like the frond of a fern. This is unlike anything seen in other ankylosaurs, which typically had club-shaped tails. The dinosaur also appeared to be less armoured and more slender-limbed than other ankylosaurs (*Nature*, doi.org/g78w).

"This is our first good look at a South American armoured dinosaur, and it is not like any armoured dinosaur you've ever seen before," says Vargas. The team thinks *S. elengassen* belonged to one of the earliest branches of the ankylosaur evolutionary tree and that the southern branch of ankylosaurs split off early in the group's evolution. **Chen Ly**

Astronomy

Massive black holes heading for collision

A PAIR of enormous black holes are getting ready for a smash-up. These objects are closer together than any supermassive pair we have spotted before, and are the nearest known pair to Earth.

Karina Voggel at the University of Strasbourg in France and her colleagues found the two behemoths using the Very Large Telescope in Chile. The larger one has a mass 154 million times that

of the sun, and the smaller one is 6.3 million solar masses.

They are in a galaxy called NGC 7727, about 89 million light years from us. The larger black hole sits at the galaxy's centre, and the smaller one is about 1600 light years to the side. It probably once belonged to a smaller galaxy that NGC 7727 swallowed billions of years ago.

Now, the black holes themselves are heading for a merger and will probably collide and become a single colossal black hole in about 250 million years (*Astronomy & Astrophysics*, doi.org/g78p).

"These processes in astronomy take billions of years, so we can't follow them as they happen, but we've caught this in the act of the merging process," says Voggel.

The black holes are more than five times nearer to Earth than the next-closest supermassive pair. The team spotted them based on the movements of nearby stars, not on the light that some black holes give off as matter falls in, which is the usual way. **Leah Crane**



ESO/VOGGEL ET AL.



Really brief



KIM TAYLOR/NATUREPL.COM

West Asian roots for common honeybee

The western honeybee (*Apis mellifera*) is the world's most common honeybee species, and a genetic study confirms that it originated in western Asia about 7 million years ago before evolving into European and African subspecies (*Science Advances*, doi.org/g8gg).

Orcas are spreading into Arctic Ocean

As sea ice vanishes, orcas – also known as killer whales – are spending more time in the Arctic Ocean and venturing further north in the region. The discovery comes from an analysis of underwater acoustic recordings captured between 2012 and 2019 (*The Journal of the Acoustical Society of America*, doi.org/g77n).

Daytime meals best even for night shifts

A small study has found that people who ate between 7am and 7pm had normal blood sugar retention but those who ate some meals at night had worse blood sugar control. This hints that it might be healthier for night-shift workers to eat during the day (*Science Advances*, doi.org/g8gh).

Space

Iron-cored planet has an 8-hour year

AN INCREDIBLY dense exoplanet seemingly made mostly of iron has joined a group known as ultrashort-period planets, because they orbit so close to their stars that their years are less than an Earth day long.

Kristine Lam, then at the Technical University of Berlin, and her colleagues spotted this world, called GJ 367b, using the Transiting Exoplanet Survey Satellite. They then did follow-up observations

using the High Accuracy Radial velocity Planet Searcher at La Silla Observatory in Chile.

The exoplanet has a radius about 72 per cent of Earth's and a mass just over half that of our planet. With those details, the team could predict its interior structure, and it probably has an iron core that takes up about 86 per cent of its radius, much like Mercury.

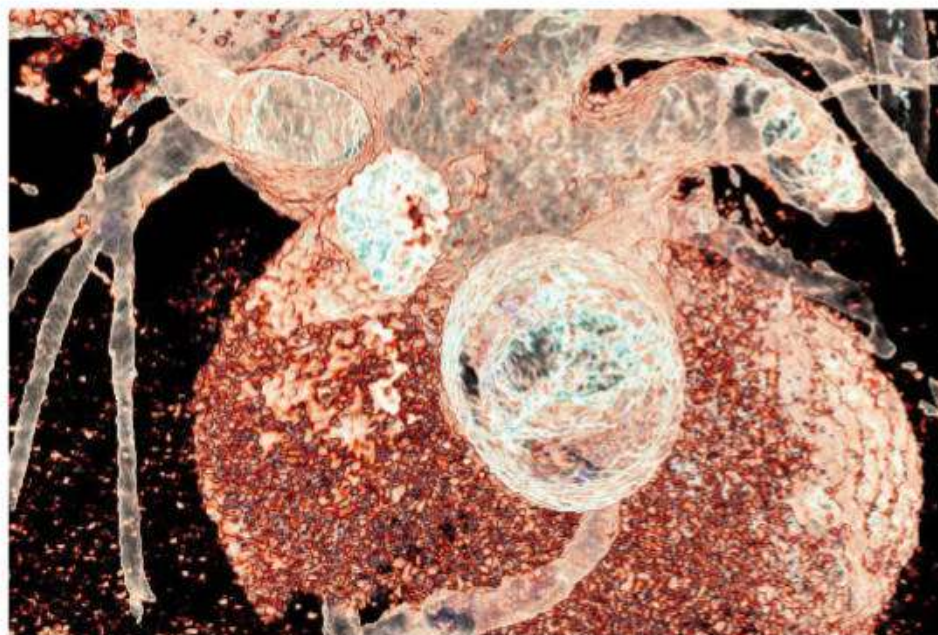
"It turns out this is one of the densest planets among the known exoplanets, and the densest and smallest of the ultrashort-period planets," says Lam. It circles its star once every 7.7 hours and the side

of the planet that faces the star gets hotter than 1400°C (*Science*, doi.org/g78n).

This is even more scorching than the dayside of Mercury and close to the melting point of iron. It could help explain why the core takes up so much of the planet, when most relatively small planets have thick, rocky mantles and crusts.

"GJ 367b is so close to its star that the heat from the star could have boiled off the rest of the planet over time," says Lam. "This could be the remains of a gaseous planet smaller than Neptune." **LC**

Genetics



VSEVOLOD ZVIRYK/SCIENCE PHOTO LIBRARY

Rare mutation linked to lower risk of heart disease

A RARE genetic mutation first found in Old Order Amish people has been shown to reduce the risk of heart disease by some 35 per cent.

The hope is that it will be possible to develop treatments with the same effect, says May Montasser at the University of Maryland.

Montasser's team studied 7000 Old Order Amish people and found that a mutation in a gene called *B4GALT1* was associated with lower levels of low-density lipoprotein (LDL) cholesterol.

It was also associated with lower levels of fibrinogen, which helps blood clot. High levels of fibrinogen seem to increase the risk of heart

disease. The mutation was present in 6 per cent of the people studied but is rare in other populations.

Looking at genetic databases revealed that this mutation is associated with a reduced risk of coronary heart disease. To confirm that the mutation is the cause, the team induced similar mutations in mice (*Science*, doi.org/g78k).

The team is now trying to work out how the mutation lowers LDL and fibrinogen so we can design drugs that have the same effect.

The team showed in mice that using CRISPR gene editing to add the mutation in liver cells may also do the job. **Michael Le Page**

Ornithology

The bird that was eagle and vulture

A HUGE carnivorous bird that went extinct about 600 years ago behaved like both a predatory eagle and a gut-raiding vulture.

To work out how the Haast's eagle (*Hieraaetus moorei*) – which lived in New Zealand and weighed up to 15 kilograms – fed, Anneke van Heteren at the Bavarian State Collection of Zoology in Germany and her colleagues created digital 3D models of specimens. They then compared those with five modern eagle and vulture species.

The researchers found that the Haast's beak is more similar to that of other eagles than to carrion feeders. Haast's eagles could have used their powerful bite to kill large prey such the now-extinct moa, which could weigh up to 200 kilograms. Their talons were also suited for catching large prey.

But the back upper part of the skull is reminiscent of a vulture's, suggesting it could bear strains similar to those of a bird that gulps down internal organs (*Proceedings of the Royal Society B*, doi.org/g78d).

A lack of competition meant they could afford to be picky, says van Heteren. After consuming the internal organs, which are rich with nutrients, and perhaps the muscles, the raptors probably abandoned the rest. **CL-L**

CAN ART THEORY BE SCIENTIFICALLY PROVEN?

Whose Truth, Whose Creativity?

is an expert analysis of neuroscience and art theory — this new book delves into the source of all art and creativity, from ancient cave paintings to contemporary art. It explores why postmodern art theory has had a damaging impact on the art world and explains how neuroscience can prove this. Does talent spring from the unconscious mind as Paul Cézanne believed? Or does it, as Marcel Duchamp theorized, come from conceptual thinking at the conscious level?

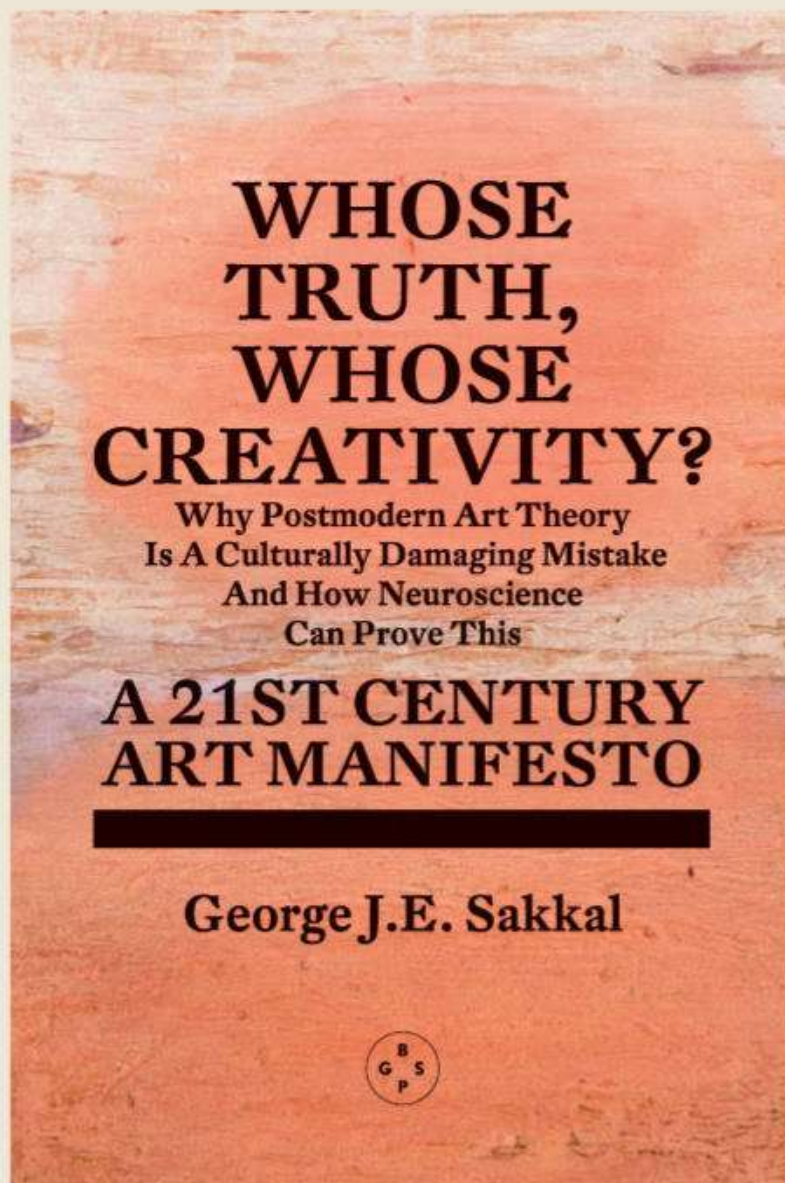


Cognitive neuroscientific psychology, a fairly new field of psychology, explains a natural, mental basis for human creativity. This book exposes the many falsehoods and distortions of postmodern reasoning to demonstrate how, by following this disturbing, unnatural direction for decades, the art establishment has been responsible for initiating an era of damaging cultural chaos.

George J. E. Sakkal: For over fifty years, his avocation has been the practice of Fine Art. In addition to winning several national and regional competitions and exhibiting his work throughout the Baltimore / Washington D.C. region, he has lectured and taught collage and his discovery, CUVISM, at the University of Maryland's Community College in Columbia, Maryland. Sakkal has served as a Peace Corps Volunteer architect from 1966 to 1968 and an Associate Peace Corps Director from 1968 to 1971, both in Iran. He has a Bachelor's in Architecture from the School of Architecture at Texas A&M University and a Master's in City Planning from Harvard's Graduate School of Design.



THE **BLACK SPRING**
PRESS GROUP



PUBLICATION DATE: DECEMBER 1, 2021
HARDCOVER • 230 PAGES • \$ 24.00 / £ 16.99
ISBN 978-1-913606-55-8 • AVAILABLE FROM AMAZON
AND BOOKSTORES ACROSS THE USA, UK AND IRELAND

His first article, *The Problem with Postmodern Art Theory*, was published by the *American Arts Quarterly Journal* in the summer of 2009. Examining the validity of the theories of contemporary art's Postmodern era resulted in his first book, *CUVISM (Cognitive Unconscious Visual Creativity): The Human Creative Response*, published in 2015.

VISIT THE AUTHOR / ARTIST AT WWW.SAKKALCUVISM.COM

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Sally Adee enjoys two sci-fi dystopias about language's power **p34**

Comment

Digital tyranny

The way the pandemic changed cyberbullying tells us how to reduce it in the future, say **Alexandra Martiniuk** and **Joseph Freeman**

CYBERBULLYING was already a problem before the covid-19 pandemic hit. In Australia, for example, one in five young people reported in 2017 that they had been socially excluded, threatened or abused online, and the same proportion said they had participated in cyberbullying themselves. Then lockdowns and work-from-home orders came into force, meaning even more time was spent online.

Yet when it comes to cyberbullying, the pandemic has had a different effect than you might expect. Although we have been online more, some studies show that cyberbullying has decreased. The reasons behind this could tell us how to better tackle this problem once we emerge from the pandemic.

Unlike in-person bullying, cyberbullying can occur 24/7 and has a stronger association with suicidal ideation. We know that teenagers already spend a lot of time online, and that is increasing. A survey of people aged 10 to 18 in 11 European countries during the 2020 spring lockdowns found that nearly half of them felt they were experiencing “online overuse”. They were online for 6.5 hours per weekday on average, and around half of that time was related to school. In 2018, the comparable number was 2.7 hours per day.

Previously, more time online had been linked with an increased chance of participating in cyberbullying. Studies have also shown that stress and anxiety have



increased during the pandemic, both of which can drive increases in anger and cyberbullying.

Yet this phenomenon has actually decreased during the pandemic. One study looked at school cyberbullying in the US using Google search data. Trends in the search term “cyberbullying” have previously matched up with actual survey data about it. This study found that searches for both “cyberbullying” and “bullying” dropped by 30 to 40 per cent relative to historical norms after US schools adopted remote learning.

Another study involving South Korean schoolchildren found that the proportion of school-aged children that were

either cyberbullying or being cyberbullied decreased from 27 per cent in 2019 to 23 per cent in 2020.

What’s going on? One reason for the decline is that in-person interactions can fuel both online and in-person bullying. Bullying tends to start in unstructured time, which doesn’t exist in the same way in online schooling. This suggests if we focus prevention efforts on unstructured time, it is likely we will stop both traditional bullying and cyberbullying.

Bullying rates aren’t fixed. When children feel nurtured and socially and emotionally safe, they bully less. During the pandemic, young people have spent more time at home with their parent or

carer. For some, this has probably provided feelings of safety – a positive effect well known to occur in times of disaster or crisis.

Positive relationships also help reduce bullying. While some families have had interpersonal conflicts during the crisis, most households worldwide have reported increased cohesion and positive bonding between family members. Studies have shown that children reflected positively about spending more time with family. Keeping these positive relationships strong may also help prevent bullying in the future.

Unstructured play is key to the development of self-esteem, self-determination and the ability to self-regulate – all vital parts of emotional development that help prevent children bullying and protect them from being bullied.

The answer isn’t to get rid of unstructured time. But by making it a more nurturing environment backed up by positive relationships, the reduction in cyberbullying seen during the pandemic may stick around for some time. ■

Need a listening ear? UK Samaritans: 116 123 (samaritans.org). Visit bit.ly/SuicideHelplines for hotlines and websites for other countries



Alexandra Martiniuk and Joseph Freeman are at the University of Sydney in Australia

Field notes from space-time

Science is being downsized Funding cuts are undermining the whole enterprise, impoverishing attempts to discover the secrets of nature and share them, writes **Chanda Prescod-Weinstein**



Chanda Prescod-Weinstein is an assistant professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

Chanda's week

What I'm reading

I am completely in love with Captioning the Archives: A conversation in photographs and text by Lester Sloan and Aisha Sabatini Sloan.

What I'm watching

Television series Star Trek: Discovery is back. Yay!

What I'm working on

An anthology about intersectionality, a framework for understanding how different forms of oppression combine and shape people's lives. I'm drafting a chapter about Black feminism and physics.

This column appears monthly. Up next week: bumper Christmas issue

THE best bits of being a particle cosmologist are the moments where I feel the mathematical pieces of an idea click into place. When I understand an equation or successfully solve one, I have the same experience I had over 30 years ago when I was learning my times tables. It is a unique kind of elation.

I realise that a lot of people have never had this experience. I write this column especially for those of you who were discouraged because I know that whether or not you love maths, most people are interested in the universe beyond their everyday lives. We are by nature a curious species.

Curiosity remains important for a scientist, but it has to be paired with persistence to become competent at what we do. The universe is complex and exceedingly difficult to understand. At some point, even for the quickest among us, the solutions we seek are far from obvious. Stephen Hawking never resolved the question of what happens at the centre of a black hole. His description of this problem in an Errol Morris documentary is what inspired me as a child to commit my life to particle physics and cosmology. I have been lucky to be able to spend my time thinking about these questions and get paid for it.

Unfortunately, too little of my day job involves thinking about these questions. Or at least that is how I feel in the midst of the covid-19 pandemic and the aftermath of academia being transformed by cuts in public funding for higher education. On the day I turned this column in, I spent 3 hours figuring out how to activate a type of online survey called a student evaluation of teaching (SET). Colleagues will

know that the intensity with which I went at this is particularly ironic, given the extensive literature showing that SETs are fraught with bias, with women of colour like me on the losing end.

This is supposed to be someone else's job. I don't mean to say that the work is beneath me. I mean more that I don't have the expertise with the tools required to make these surveys, and I have an array of other tasks that actually are my job. In the language of my workplace, today I experienced an administrative burden that became a barrier to me conducting my instructional

“Academics now have less time to investigate the big questions and to pass on our knowledge”

duties. Which is to say, there are student emails with questions about astrophysics – one of my areas of expertise – that have gone unanswered because I was too busy figuring out how to ask the students how they rated me.

This sort of thing sabotages the scientific enterprise, reducing the amount of time we get to do what we trained for: investigating big questions and passing on our knowledge to the next generation. Academic work requires a community of labourers, from the people who pick up our rubbish and clean our toilets to the administrators who are tasked with helping us with paperwork. The whole thing falls apart when staff are downsized or asked to cut their hours, leading to a loss of both income and essential benefits for them. Without administrative staff to help us manage that load, teaching and

research staff – the majority of whom are term-to-term appointees with no semblance of job stability – do more and more of the work, squeezing our other responsibilities and commitments.

These changes in academia in response to economic and political pressures are but one example of the social challenges that make it difficult to sustain a focus on the beautiful mysteries of the universe.

Within US universities and beyond, too many workers are earning too little, with insufficient benefits. Our social safety net is in tatters. While the UK still has a better health system than we do, I'm not sure for how long. And I see that many academics in the UK have been striking in the past couple of weeks to protest pay and working conditions.

Our nations share in common a crisis of failing and absent support at government level for refugees and other immigrants, leading to tragic outcomes. Politicians claim we can't afford to make room for them. Meanwhile, I pay a bigger percentage of my income in taxes than billionaires like Jeff Bezos and Elon Musk.

In the context of our unnecessarily dehumanising social structures, my admin burden might seem insignificant. But I'm talking about the same thing: political structures that shift money away from important community activities and into the pockets of billionaires while devaluing our humanity, our work and our right to experience and share wonder. I want better for us.

I continue to hope for a world where strangers in a strange land are always warmly embraced and can find community in a shared curiosity about the universe beyond our atmosphere. ■

GALAXY

ON GLASS

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**I would like to wish the New Scientist team and all the readers
Season's Greetings and good health. Chris Baker**

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or head to **www.galaxyonglass.com**



Editor's pick

At last, survival of the kindest is centre stage

27 November, p 38

From Howie Firth, Elgin, Moray, UK

Congratulations on "The last human", a superb article on the increasing evidence that human survival through harsh times was a result of our skill at working together. It is timely, both post-COP26 and in this centenary year of the death of Russian scientist Peter Kropotkin, who argued that evolution was driven by mutual aid within a species.

This could be a good time to revisit his conclusions and the mass of evidence he gathered in support of them.

Fundamental problems are at the core of poor diets

Letters, 20 November

From Nick Hunn, London, UK

Richard Sebes stating that no health-conscious vegan would live on junk food misses the point of the original article (30 October, p 38). As a meat eater, I share the view that no health-conscious carnivore would live on junk food either, but a very large proportion of the population does.

The problem is that many parts of the world have had decades of policy that says food must be cheap, exacerbated by the fact that at least two generations haven't been taught to cook. This has given the food industry the chance to process more and more of our food.

If we are going to improve our health, reduce food waste and move to sustainable ingredients, we need to tackle such problems.

We must be pragmatic about climate pledges

13 November, p 8

From Gerald White,

St Brelade, Jersey, Channel Islands

The pledge by many nations to achieve net-zero carbon emissions

by 2050 is intended to address global heating, but the most we should expect from this is for raised temperatures to perpetuate for decades thereafter, due to inevitable lags between causes and effects.

We should honestly acknowledge that our objectives are constrained by realpolitik. The best we can aim for is to prolong our current human civilisation, to minimise present-day disruption and to protect future generations as far as we can by spreading out in time the adaptations required to survive in a hotter, harsher and more challenging world.

That isn't an ignoble aim. It appears to me to be the de facto objective of the actions taken so far by world governments, but it falls some way short of saving the planet.

The great unanswerable question about alien life

20 November, p 36

From Eric Kvaalen,

Les Essarts-le-Roi, France

Abigail Beall says that it seems unlikely that there are no aliens, given the huge number of planets in the cosmos. But we have no idea how life gets started, so even if there are zillions of planets, we can't say that it is likely that there is life.

On the other hand, although she cites SETI pioneer Jill Tarter as saying that we haven't listened for long enough or looked hard enough for signals from intelligent extraterrestrials or for signs of them to be able to say that there are no aliens, the fact is that we will never be able to say that there are none.

If we find that there are aliens, then we could answer the question

in the affirmative (though I doubt we will), but we can never answer the question in the negative.

Rise in air conditioning use seems inevitable

Letters, 16 October

From Richard Keyworth,

Woodbridge, Suffolk, UK

Fred White exhibits a very British attitude to the decadent air conditioning, though many of us have come to love it in our cars.

He is obviously well aware that cooling in general already accounts for 10 per cent of global emissions, a figure set to soar as billions more air con units are brought into use worldwide in the coming decades. No amount of clever passive design, shading, planting and venting will save us when a 45 to 50°C heat dome settles over north-west Europe.

I am peripherally involved in upgrading the heating in our village hall. We are looking at air-to-air cabinet-style heat pumps, and if possible I will make sure they can work in reverse to cool, powered when needed by solar panels on the roof. I can foresee a time when people will seek out the village hall to cool off.

We are still building homes unsuitable for heat pumps

23 October, p 9

From Paul Whiteley,

Bittaford, Devon, UK

There is more and more hype regarding the push for air source heat pumps. On the edge of our small town, 300 houses are being built, all with gas boiler heating and standard insulation levels.

To retrofit these with heat pumps and have the recommended air circulation space of a metre on all sides of the

pump would mean the occupants giving up almost half of their small gardens, leaving them with barely enough space for a washing line.

As all the houses have wooden panel fencing, there would be insufficient air flow around the gardens on cold, still nights, reducing heat pump performance at a time when heat is needed.

Unintended consequences of our renewable future

13 November, p 38

From Don Baldwin, London, UK

Graham Lawton's article on the scaling up of mineral extraction for renewable technologies reinforced my fears that wholesale conversion to electric vehicles would generate its own problems, and that these may have been underestimated.

I may not live to see the day, but lorries, aircraft and possibly cars could be powered by green hydrogen, with their fuel made from seawater using surplus electricity. To this end, we need to maximise electricity generation.

We should learn a lesson from industrialisation that plundering natural resources for coal, oil, gas and now moving on to zinc, copper, lithium, nickel, cobalt, manganese and rare earth elements has had – and will continue to have – unfortunate environmental and political consequences.

Let's deploy AI on other great problems in science

31 July, p 14

From Andrew Hawkins,

Peaslake, Surrey, UK

Harking back to your coverage of the achievements of DeepMind's AI approach to protein folding, I wondered if the long-standing problems of creating a suitable material for a room-temperature superconductor and of practical fusion power might be good subjects for this technique.

Breakthroughs in these issues would certainly contribute a great deal to the current threat of global warming. ■



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Ghostly fungi



Photographer Jürgen Freund
Agency Naturepl.com

THIS haunting shot of a bioluminescent fungus may seem otherworldly, but you can witness the astonishing sight in forests here on Earth. The photo was taken in the Atherton Tableland plateau in Queensland, Australia, by nature photographer Jürgen Freund.

This species is probably *Omphalotus nidiformis*, otherwise known as the ghost fungus, so-named for its characteristic glow-in-the-dark properties. It is one of more than 100 known fungus species that bioluminesce, or generate their own light.

The ghost fungus actually glows continuously, as a compound within *O. nidiformis* called luciferin – the same substance that makes fireflies shine – reacts with the enzyme luciferase and oxygen.

The evolutionary benefit of the glow of the ghost fungus and other species like it is unclear. One theory is that the light attracts insects, which help the fungus to disperse its spores more widely and colonise additional regions of rainforest. But it could simply be an incidental by-product of metabolism.

Freund's image was highly commended in the Plants and Fungi category of this year's Wildlife Photographer of the Year competition, organised by the Natural History Museum in London. ■

Gege Li

Invasion of the tiny aliens

Sci-fi meets road trip in *Encounter*, a film that starts well, but then veers off course just when it is starting to get fun, says **Gregory Wakeman**



Film

Encounter

Michael Pearce

UK cinemas, Amazon Prime

ENCOUNTER brings together three of the most exciting stars in the British film industry: director Michael Pearce, whose debut feature *Beast* was critically acclaimed on its release in 2017, screenwriter Joe Barton, who created the equally lauded *Giri/Haji*, and Riz Ahmed, whose performances in *Four Lions*, *The Night Of* and *Sound Of Metal* secured his status as one of the UK's best actors.

For the first half of *Encounter*, their talents complement each other perfectly. Ahmed stars as Malik Khan, an ex-soldier on a mission to rescue his two young children Jay (Lucian-River Chauhan) and Bobby (Aditya Geddada) when the world comes under attack from an extraterrestrial invasion that is made more terrifying by the fact that the aliens come in the form of parasitic microorganisms that first infect insects, then move on to tackle humans.

Encounter begins by immediately establishing the seriousness of the extraterrestrial threat. Before the title sequence even hits the screen, we see the aliens arrive on Earth, attack insects and then quickly explode in numbers. Pearce shoots this sequence with a detail that is simple to follow yet sinister and creepy. So much so that the subsequent shots of insects will make your skin crawl.

The action ratchets up further when Malik's ex-wife Piya (Janina Gavankar), who doesn't see the rescue in quite the same light, informs the authorities that her



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children have been kidnapped. Special agents Shepard (Rory Cochrane) and Hattie (Octavia Spencer) are put on the case and set off in pursuit across the mountains and deserts of California and Nevada.

“Ahmed commands the screen, giving Malik a toughness and intensity as the story progresses”

At this early stage of the film, it is a blast, successfully towing the line between a riveting sci-fi drama and a road-trip movie.

Ahmed commands the screen instantly, giving Malik a toughness and intensity that emerge gradually as the story progresses. The young actors who play his sons are just as impressive, but for very different reasons. It won't take long for audiences to be charmed by Geddada, who brings a much needed levity and heart to the film. Chauhan becomes more confident as time goes on, displaying an impressive maturity

and strength of character. Pearce gives Malik, Jay and Bobby the space to build a genuinely touching connection.

With all this going on amid the beauty and desolation of the Californian mountains, it is impossible not to be drawn into the story. Barton's economical and believable script propels the film forwards, while providing just enough backstory on the alien attack to keep audiences intrigued. The soundtrack, too, subtly makes the alien creatures feel present and menacing, without ever allowing the sound of their advancement to get in the way of the scene-building and storytelling.

Then, just when *Encounter* is really getting under way, Pearce hits us with a seismic shift in direction. While potentially a deliberate ploy to surprise the audience and keep us engaged, it doesn't quite work. Instead, it disrupts what was building into a beautiful and unnervingly atmospheric experience and throws us for a loop. For a good 10 minutes after this turn, it feels

Malik (Riz Ahmed, centre) is determined to prepare his sons to fight the aliens

as if the story is thrashing around. It is unnerving to say the least.

Despite this unexpected shift in perspective, the narrative isn't entirely derailed. It soon finds its footing again, and Ahmed's continually powerful performance ensures that *Encounter* remains intriguing all the way to its finale. Chauhan, alongside him, does a great job at keeping the intensity high.

On the other hand, anyone who was enjoying the sci-fi-cum-road-trip experience may find themselves less invested in the more intimate and psychological character study that *Encounter* becomes. Ultimately, by the time the credits roll, it feels like two separate movies that have been jammed together to form an uneven psychological sci-fi thriller that, while good, could have been so much more. ■

Gregory Wakeman is a journalist based in Los Angeles

Secrets of the dead

A brilliant scientist finds a way to mine memories from beyond the grave, but it comes at a cost, finds **Josh Bell**



TV
Dr. Brain
Apple TV+

WITH a name like Dr Brain, the title character of the first South Korean-language series from Apple TV+ sounds like he should be a second-string Marvel superhero. Yet while Dr Sewon Koh (*Parasite*'s Lee Sun-kyun) does have superhuman powers of a kind, he isn't a superhero, and no one actually calls him Dr Brain.

The series is an adaptation of a South Korean webtoon in which a neuroscientist develops a way to mine the brains of dead people for their memories, which he can weave into his own. Despite the somewhat absurd premise, this adaptation plays it mostly straight, keeping its story grounded in character drama and sci-fi.

Sewon is a talented and eccentric neuroscientist who has devoted his life to understanding how brains work. He develops a technology called brain syncing, which connects two brains through a silly-looking contraption made of wires, dials and blinking lights that are supposed to have something

to do with quantum entanglement. The details are hazy, but series director and co-writer Kim Jee-woon presents it all with due reverence.

Sewon decides that he must be the first human test subject for his invention. So he tasks his assistant with procuring a fresh body from the morgue and hooks himself up to the dead man's brain.

As we soon discover, Sewon's motivation for uploading other people's memories isn't solely scientific curiosity. He also comes overburdened with a tragic backstory, which began when his mother was killed in a road accident when he was a child. Then, years later, he saw his young son die in a house fire and his wife fall into a coma after a suicide attempt – a condition in which she remains.

The incidents with his wife and son occurred under mysterious circumstances, and soon after Sewon's first brain sync, he is visited by a private investigator who is also looking for answers about those tragedies. The police soon show up, too, and *Dr. Brain* morphs into

When Dr Sewon Koh uploads memories from dead people, he doesn't always like what he sees

a murder mystery, as Sewon uses his skills to uncover a shadowy conspiracy that is targeting him and his family.

However, the more brains that Sewon syncs with, the more his mind fractures, as bits of the personalities and skills of the subjects take hold in his own brain. At one point, he hooks himself up to his family's dead cat, which may have witnessed a murder. From then on, he possesses cat-like abilities, allowing him to quickly climb a tree, see better in the dark and land on his feet when jumping from a building. It is an appealingly goofy touch in a series that sometimes takes itself too seriously, given its somewhat outlandish premise.

Kim, who is best known outside South Korea for mind-bending thrillers *A Tale of Two Sisters* and *I Saw the Devil* (as well as Arnold Schwarzenegger action movie *The Last Stand*), directs *Dr. Brain* as a mix of mundane police procedural and bizarre head trip.

The middle portion of the six-episode series drags a little, as it focuses more on crime solving and less on brain syncing. But Kim reliably returns to the surreal imagery of Sewon's visions, regardless of whether he is hooked up to another brain or just receiving some crucial piece of insight. The director also stages some exciting action sequences, including a chase through a mall and a close-quarters fight in an empty cargo transport.

Dr. Brain isn't quite as out there as fans of Kim's best-known films might hope for (or as its faintly ridiculous set-up might suggest), but it is still an entertainingly off-kilter take on a murder mystery, with a protagonist who is admirably committed to his own strange ideas. ■

Josh Bell is a writer based in Las Vegas



COURTESY OF APPLE

Don't miss



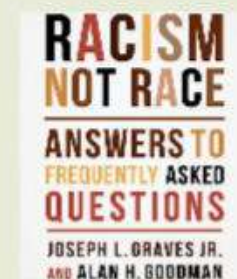
Read

Absynthe by Brendan Bellecourt is a delirious tale of altered realities set in a world where the first world war ushered in a technological utopia of automata and monorails, plus a serum that can give people telepathic abilities.



Visit

Cancer Revolution at the Science and Industry Museum in Manchester, UK, explores the new science that is allowing more of us than ever before to live longer and better with the disease. The exhibition is free and runs until March 2022.



Read

Racism, Not Race is a rigorous discussion of the scientific answers to questions of race. Joseph Graves Jr and Alan Goodman explain why race isn't a biological fact and ponder why society continues to act as if it is.

CANCER REVOLUTION/MARK WAUGH

The sci-fi column

The power of language Two visions of a dystopian future examine how words can be used to get inside our heads and to command loyalty to causes that definitely don't deserve it, finds **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee



SVETAZISHUTTERSTOCK

Are we really just puppets being controlled by the words of those in charge?

colonised humanity back in the mists of time, shaping the way we communicated ideas. Then one human finds a way to weaponise these mind viruses into “power morphemes”, sounds that can bypass logic and motor control to evoke a particular feeling, action or belief.

This book won't be for everyone. It veers wildly from one style to the next: one minute it reads as a snackable version of *Ready Player One*, the next it channels the loopy extravagance of Douglas Adams, then it abruptly skids into the style of a dense Wikipedia entry. In between the main plot, driven by a glitter-caked, disco-themed multiplayer game where bad guys are killed with a kaleidoscopic beam, Moore plunges into discursive ravines where he explores concepts like memetics and the weaponised persuasion tactics of the advertising industry.

These are very different books by very different authors, but the thread running through both is the unstoppable evolution of persuasion techniques. Using words as weapons is as old as advertising and politics, of course. The question is where the iterations will end. In *Outcast*, the endpoint is that your employer determines whether you live or die, and you think that is good and fair. In *Battle of the Linguist Mages*, others can use words to control your ability to think.

What's scary is that if language as a form of mind control is even theoretically possible, you can be sure some executive has assigned a working group to it. This is the world we live in now. But at least we get to laugh at it through the medium of science fiction. ■



Books

Outcast

Louise Carey

Gollancz

20 January

Battle of the Linguist Mages

Scotto Moore

Tordotcom

11 January

Sally also recommends...

Book

How to run a city like Amazon, and Other Fables

Edited by Mark Graham, Rob Kitchin, Shannon Mattern and Joe Shaw

Meatspace Press

Ever wondered what it would be like to live in a city run by one of 38 major tech companies? Find out in this academic speculative fiction vision of the future.

“YOU’VE exceeded everyone’s expectations.” These are words that Tanta, the hero of Louise Carey’s *InScape* series, hears often from her boss. The resulting dopamine rush is strong enough to make her knees tremble and to reinforce her total devotion to her employer, InTech.

InTech isn’t just any tech company. It is also the local government, a role it assumed in the wake of a global disaster that obliterated nation states. Civil rights have been replaced by end-user licence agreements, and violations of community guidelines get you executed.

Tanta, like most of her coworker-citizens, has internalised her company’s values so completely that the worst thing you can say about someone is that they are “not being very corporate”.

In *Outcast*, the second book in the series, Tanta has been assigned the task of finding the deeply uncorporate mole who is selling company secrets. But there is a twist: first, she needs to rid her mind of the phrases used by the corporate autocracy to command

loyalty in its citizen-employees.

This is the point at which the series pivots to deft satire, skewering the cult-like employee culture that exists not only in Carey’s dystopian future but in our present, too. From Mark Zuckerberg’s exhortation to “move fast and break things” to Disney’s insistence that all

“In *Outcast*, your employer determines whether you live or die and you think that is good and fair”

its employees, down to the janitorial staff, identify as “cast members”, corporations already use certain phrases to get inside employees’ heads. Carey has a degree in psychology, which clearly informs her send-up of the way companies do this.

In *Battle of the Linguist Mages*, Scotto Moore takes the idea of weaponised linguistics to the next level. In this world, human language began as an embedded sentient alien mind virus that

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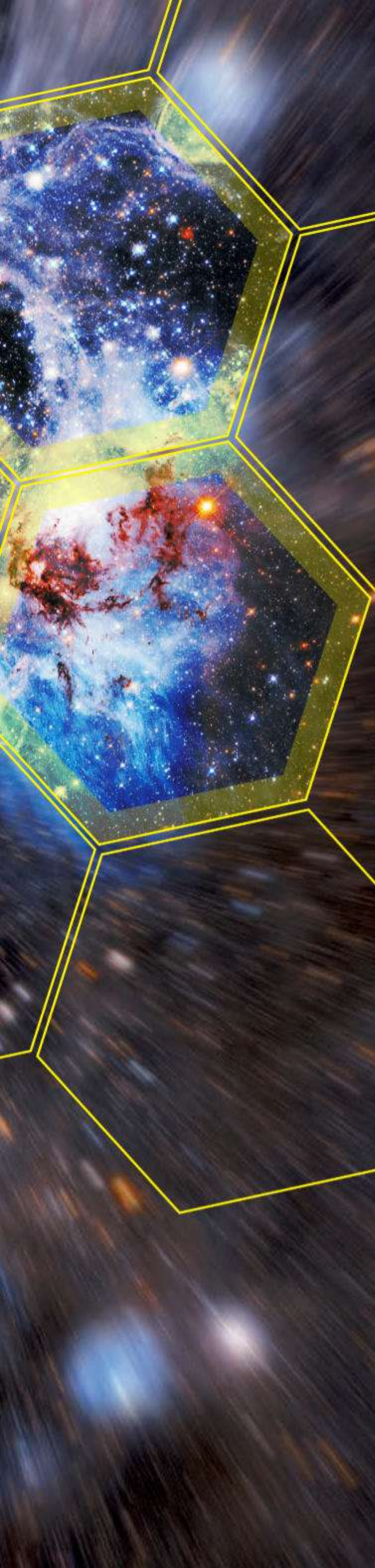
IN EARLY October, a cargo ship steered to starboard, leaving the Atlantic Ocean off the east coast of South America and entering the muddy waters of the Korou river. It was the final phase of the voyage and no effort had been spared to protect the prized item on board. It was housed inside a specially designed case to keep it safe from the pitch and roll of the waves. The river had been dredged to ensure the ship didn't get stuck in the shallows. Even the exact date of the voyage had been kept secret, to avoid the attention of pirates.

The precious cargo was the James Webb Space Telescope, perhaps the most hotly anticipated scientific instrument ever. Known as the JWST, the telescope has been more than 25 years in the making and its launch has been delayed countless times. But it has now completed its voyage to the launch site in French Guiana and, if all goes smoothly, it will finally leave Earth in late December. "I still haven't wrapped my head around it," says Torsten Böker, deputy project scientist for the JWST at the European Space Agency (ESA). "It seems a little bit unreal."

Unreal not only because it has often looked like the telescope might never take off, but also because this device is designed to be a time machine that will help us see back to the enigmatic era of the universe's first stars, which we know precious little about. Unreal, too, because it will reveal the atmospheres of

Launch of a time machine

The most powerful telescope ever made is about to blast off. It will show us the first stars and the atmospheres of alien worlds, says **Colin Stuart**



“We’ll make 400 years’ worth of discoveries in a decade”

potentially habitable planets orbiting other stars more clearly than ever before. It is no exaggeration to say that this telescope, with its gigantic gold-plated mirror, will transform our view of the universe and our place in it.

The JWST’s story begins around Christmas 1995. That year, the world was gripped by O.J. Simpson’s murder trial, Bridget Jones first appeared in print and *Forrest Gump* won big at the Oscars. For 10 December days, the Hubble Space Telescope stared at a patch of featureless sky that could be covered by a pinhead held at arm’s length. As far as ground-based telescopes were concerned, this region of the sky was empty. But some astronomers suspected that a closer look was warranted.

What emerged, now known as the Hubble Deep Field image, showed that this patch of space is crammed with 3000 galaxies, each about 4 billion times fainter than the human eye can see. Among them were the oldest galaxies we had ever viewed.

Light may be fast, but it still takes a lot of time to reach us when travelling across the universe. Because of this, we know that the further objects are from us, the older the light from them is. But how to tell the age of any given star or galaxy? Fortunately, a quirk of starlight can help. Because the universe has been expanding since the big bang, light travelling long distances gets stretched out as it goes. This changes its wavelength, pushing it

from the visible spectrum further into the infrared. This “redshift” was extreme for some of the galaxies Hubble had discovered, showing that they were more than 10 billion years old. That takes us a long way back towards the big bang 13.8 billion years ago.

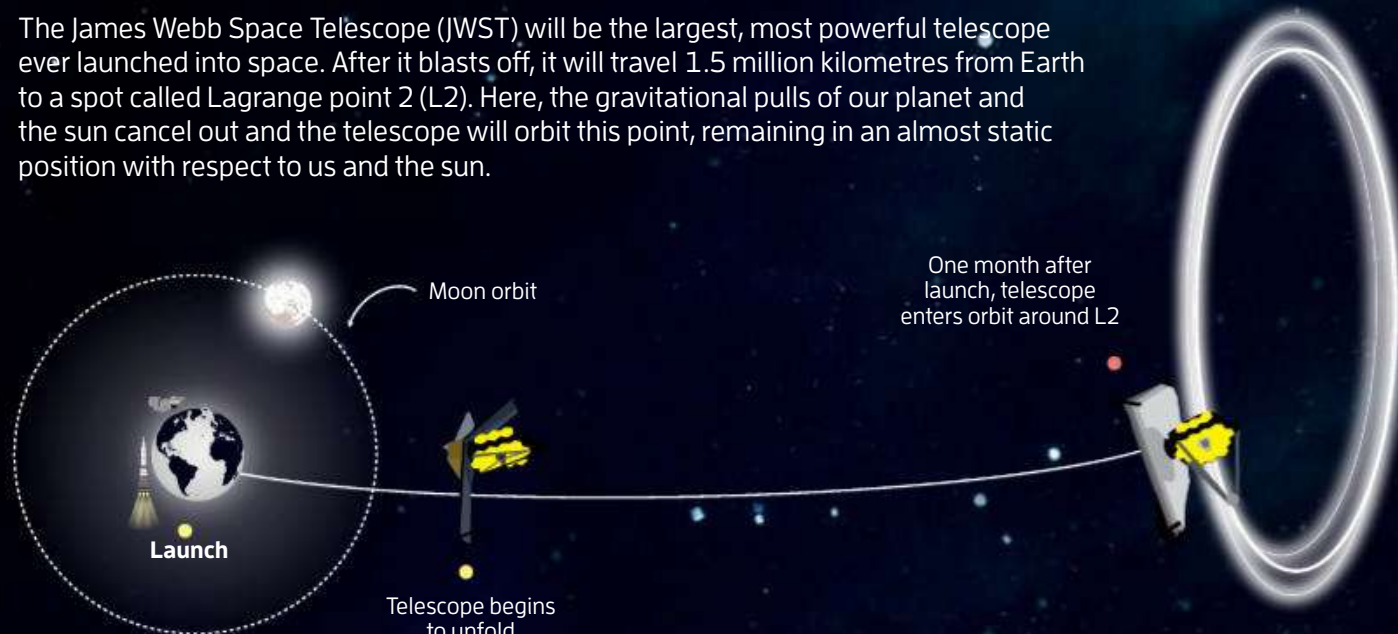
Astronomers hadn’t expected that galaxies this ancient would be detectable, especially not in such numbers. Appetites whetted, they hatched a plan to get a better look at the universe in its flush of youth. In early 1996, a group of stargazers convened to kick-start work on what was then called the Next Generation Space Telescope. That became the JWST, which is now a joint project between NASA, ESA and the Canadian Space Agency. It is only now getting its chance on the launchpad; scientists have wrinkled and greyed as a single telescope project took up most of their career.

As they waited, the thirst to see the universe’s first stars deepened. A star produces chemical elements inside it as it burns, then spews them into space as it dies, often in an explosive supernova. Some of that debris eventually coalesces into a new generation of stars – and the cycle repeats. Going back in time, it is thought that stars would have been made of mixtures of simpler elements. The first stars would have formed from clouds of hydrogen and helium, the simplest elements, at a point called the cosmic dawn. They would have started to form heavier elements, but ➤

The James Webb Space Telescope

How it works and what it will see

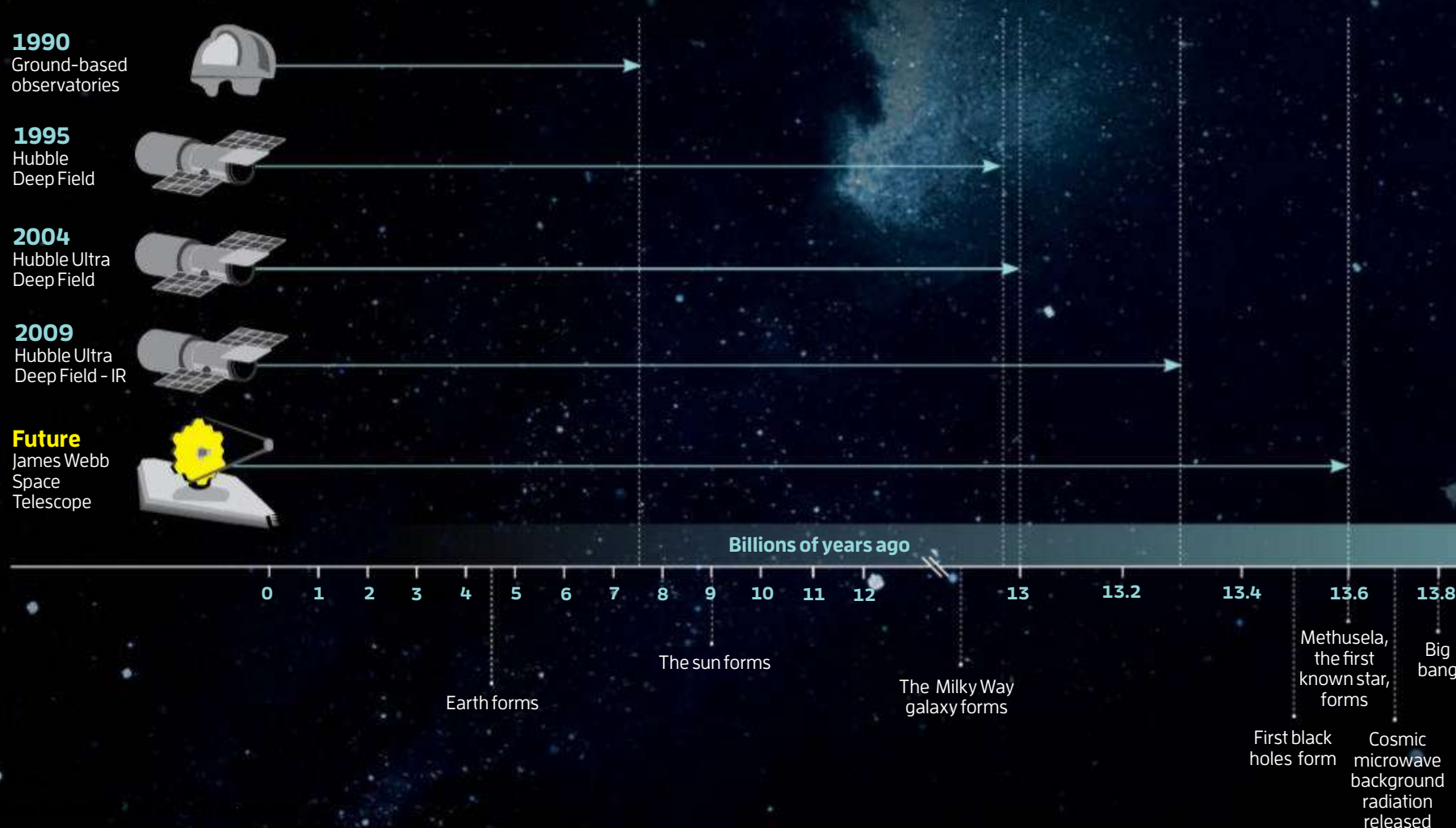
The James Webb Space Telescope (JWST) will be the largest, most powerful telescope ever launched into space. After it blasts off, it will travel 1.5 million kilometres from Earth to a spot called Lagrange point 2 (L2). Here, the gravitational pulls of our planet and the sun cancel out and the telescope will orbit this point, remaining in an almost static position with respect to us and the sun.



The telescope is designed to pick up the tiniest specks of infrared radiation, or heat, from ancient stars and galaxies. Orbiting so far from Earth, the sun and moon makes it easier to avoid heat coming from those bodies. Nonetheless, the JWST will need a huge heat shield, which will be unfurled on its journey through space.



Once the telescope is unfolded, it will begin taking test images and adjusting the alignment of its primary mirrors. After six months, it should be ready to start science observations. It will be able to see further back in time than we have ever managed before.





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only slowly. The trouble is, our accounting for where the universe's heavy elements came from doesn't add up. One idea is that the mysterious first stars had a more important role in creating them than we thought.

So far, we haven't been able to properly see stars that lived in the first few 100 million years after the big bang – all we have had are indirect glimpses. Light from the first stars is thought to have interacted with leftover hydrogen in the early universe, changing the way that gas absorbed the cosmic microwave background (CMB), remnant radiation from the big bang that we can still detect. In 2018, the researchers behind a radio-astronomy experiment known as EDGES announced that they had managed to see this change in the CMB and so get an indirect signal from the first stars. Some scientists saw this finding as ambiguous, however, because the signal is subtle and it didn't look exactly as had been predicted.

Meanwhile, the light from a few of the first stars shines towards us on a path that takes it close to a cluster of galaxies. The gravity of these galaxies acts like a magnifying glass that allows us to see the starlight. But this only happens in a few lucky cases.

The JWST should sweep all this aside and give us a better look. While Hubble is known for producing incredible visuals, the JWST is primarily designed to see infrared light from the earliest stars. We have already had infrared telescopes in space, such as ESA's Herschel Space Observatory, which was retired in 2013. But we are getting quite the upgrade. "The sensitivity of JWST is 100 to 1000 times higher than current or previous infrared telescopes," says Roberto Maiolino at the University of Cambridge. He sees it as akin to jumping from Galileo Galilei's telescope to modern mountaintop observatories. "We'll make 400 years' worth of discoveries in a decade," he says.

Maiolino works on the JWST's near-infrared spectrometer, one of the key pieces of tech that will help make those discoveries. The instrument splits up starlight into its constituent frequencies, enabling us to measure the intensity of light at each one. Certain elements absorb light at characteristic frequencies and so the missing chunks of light will show us what elements are present in the oldest stars and galaxies. "We're going to spend a lot of time taking deep spectra of the first galaxies," says Maiolino. "We want to know how early key elements formed in the universe."



NASA/CHRIS GUNN



NASA/CHRIS GUNN



NASA/CHRIS GUNN

Removing covers from the mirrors of the James Webb Space Telescope (top), the telescope folded (middle), and after cryogenic testing (bottom)

There is, however, a major problem when it comes to observing infrared light. It isn't just given off by ancient stars and galaxies, but by warm objects of all kinds – including the sun and our planet. This means that a space telescope can't simply be placed in a typical Earth orbit. Heat from Earth would blind it to the faint glimmers from ancient stars. It would be like trying to hear a whisper at the universe's loudest rock concert. That's why the JWST has a huge sun shield and why it will be placed at a special point in space about four times further from Earth than the moon is (see diagrams, left). If the first phase of the telescope's journey by sea was tense, then the 1.5-million-kilometre passage through space is truly epic.

Transformer in space

This new eye in the sky is also the largest space telescope in history. Its 6.5-metre mirror – taller than a four-storey building – couldn't fit inside a rocket in its final configuration. So it is made of 18 hexagonal segments that will be folded up for launch, only to unfurl when the telescope reaches space. "It's like a giant Transformer going up into space," says Knicole Colón, a deputy project scientist for the JWST at NASA. Each mirror segment is covered in an incredibly thin layer of gold, which significantly increases the mirror's ability to reflect and focus infrared light.

The telescope has been dogged by setbacks and controversy. Original estimates suggested that it would cost \$500 million. That has ballooned to \$9.7 billion. In 2011, a US House of Representatives committee attempted to pull the mission's funding due to it being "billions of dollars over budget and plagued by poor management". Then a planned launch date in 2018 was pushed back due to technical problems with the telescope's sun shield and thrusters. The covid-19 pandemic resulted in more delays. Even in the past few weeks, problems have cropped up. In late November, NASA announced that the "sudden unplanned release of a clamp" had sent vibrations through the telescope and it needed time to ensure no damage had been done. As this story went to press, the launch was scheduled for no earlier than 22 December.

Even the name has caused issues. James Webb was the NASA administrator in the early days of human space flight. He was a politician, not a scientist. Worse, some accuse him of having being involved in the lavender scare of the mid-20th century, an effort to oust ➤

Eyes in the sky

Several space telescopes slated for launch after the James Webb one promise to deliver incredible science. Here are three of the most important

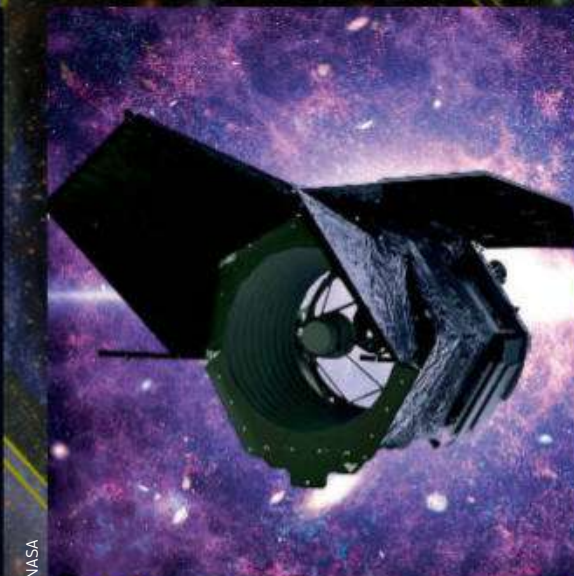


ESA/ATG MEDIALAB

PLANETARY TRANSITS AND OSCILLATIONS OF STARS (PLATO)

Expected launch date: 2026

This European Space Agency project will scour a million stars looking for blips in their light that betray the presence of an orbiting planet. Similar kinds of previous telescopes have only been able to see planets that are close to their stars and so pass in front of them frequently. Plato will linger on each star for longer and so has the chance to detect planets that are more distant from their star, with a longer orbital period. In particular, the mission is focused on trying to spot signs of rocky exoplanets in the habitable zone, the narrow region of a star system in which temperatures are right for liquid water. It also has the tools to characterise such worlds, providing clues as to how Earth-like they may be.

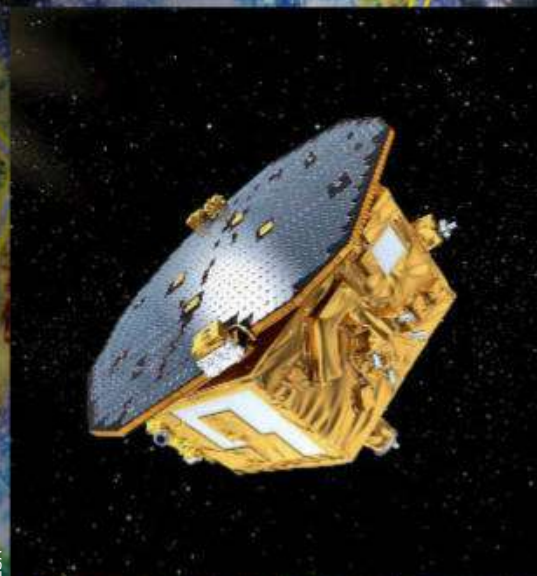


NASA

NANCY GRACE ROMAN SPACE TELESCOPE

Expected launch date: 2025

Like the James Webb Space Telescope (see main story), the Roman Space Telescope, named after the first female executive at NASA, will observe mainly infrared radiation. But while the JWST focuses on detail, Roman is going for the big picture. The telescope has a panoramic field of view more than 100 times greater than the JWST's. During its first five years, Roman will image more than 50 times as much sky as the Hubble Space Telescope covered in its first 30 years. That will allow it to make the first wide-field infrared maps of the sky. It is hoped this will help solve mysteries like the true identity of dark matter and dark energy. Astronomers can see the influence of these substances on the universe but have not been able to explain what they are.



ESA

LASER INTERFEROMETER SPACE ANTENNA (LISA)

Expected launch date: 2034

We first detected gravitational waves, ripples in the fabric of space, in 2015. So far, we have seen waves from black hole and neutron star collisions. LISA, a mission led by the European Space Agency, will be a much larger gravitational wave detector than existing ground-based ones. It will consist of three spacecraft positioned 2.5 million kilometres apart in a triangular formation. This space detector will be sensitive to gravitational waves with extremely low frequencies. Among other things, it could allow us to spot planets in other galaxies just from the subtle way in which they influence the gravitational waves produced by their parent stars. Until now, all confirmed discoveries of exoplanets have been in our own Milky Way galaxy.

“The chemistry of exoplanet atmospheres will show up clearly in the light the telescope detects”



NASA/MSFC/DAVID HIGGINBOTHAM

suspected members of the gay community from government roles. NASA says it conducted an investigation and has found “no evidence at this time” of a direct connection between Webb and the lavender scare. That hasn’t stopped scientists such as *New Scientist* columnist Chanda Prescod-Weinstein calling for a name change.

For the most part, the myriad delays have been a source of frustration. But there has been a silver lining: they mean we will be able to use the telescope in an even more exciting way.

Alien planets

Back in 1995, we barely knew of any planets beyond our solar system. The first exoplanet around a sun-like star was discovered just two months before the Hubble Deep Field image was captured. But in the quarter of a century since, we have tracked down more than 4000 of these alien worlds and begun to find out what they are like. Exoplanets are too dim and distant to be seen directly with existing telescopes. Instead, we tend to spot them by looking at distant stars and seeing when their light dims slightly as a planet moves in front. Some of this light passes through the planet’s atmosphere, where certain frequencies are absorbed by the chemicals there. By looking at



NASA/CHRIS GUNN

A technician inspects the James Webb Space Telescope’s mirrors (bottom); six mirror segments are prepared for testing in a cold chamber (top)

this light, we can get an idea of what exoplanets are like, learn what their atmospheres are made of and even develop a feel for their weather. All this is so tantalising because it tells us about other planets that might have the right conditions to support life.

So far, almost all of our observations of exoplanets have involved visible light. But the chemistry of their atmospheres will show up much more clearly in the infrared, the kind of light that the JWST is optimised to detect. The delays to the telescope’s launch allowed its design to be tweaked so it can also observe alien worlds more effectively. “Almost no exoplanets have been studied at these wavelengths before,” says Colón. One especially exciting prospect is that bonds between carbon atoms – a telltale sign of the organic chemistry that provides the scaffold for life on Earth – will show up clearly in the infrared.

There are plenty of other telescopes in the works that will complement what the JWST can do (see “Eyes in the sky”, left). Even so, some people see this venture as a case of putting too many eggs in one basket. A mountain of cash and 25 years of work have been poured into a single telescope that now faces a risky journey to its destination. Were it to fail, it might seem wiser to have spread that effort across other projects. But for the most part, astronomers are just plain excited. “It’ll be revolutionary,” says Colón. “It is completely worth it.”

The telescope is scheduled to complete its set-up procedures in the middle of 2022 and then begin gazing back in time at the enigmatic lives of the first stars and at Earth-like planets orbiting other stars. New telescopes tend to bring unanticipated discoveries too – just look at how Hubble shocked the world when it stared at that apparently blank patch of sky. “We should expect to be surprised,” says Böker. “We’ll see things we’ve never even dreamed of – you can’t put a price tag on that.” ■



Colin Stuart is an astronomy author and speaker. Follow him on Twitter @skyponderer



The Amazon's last chance

The Amazon could be facing irreversible collapse in just five years, with catastrophic effects for the planet, writes **Graham Lawton**



TOP: LUCAS BUSTAMANTE/NATUREPL; BOTTOM: VICTOR MORIYAMA

Above: The Ecuadorian Amazon; Below: Soya plantations in Brazil

IT IS perhaps the most iconic symbol of life on our planet. The Amazon is the world's largest and most biodiverse tropical rainforest, and an immense trap for carbon dioxide. The perils of deforestation in this vital resource are old news. But now, the time on the clock is running out. It seems that the world's biggest rainforest is about to turn into the world's biggest environmental disaster. "We are about to collapse," says Luciana Gatti at Brazil's National Institute for Space Research. "We are in an emergency, we need action now."

Gatti has spent years observing the Amazon from the air. She believes we are as little as five years from a point of no return, where lush rainforest irreversibly begins to convert into dry savannah. It is also the point at which billions of tonnes of carbon would be dumped into the atmosphere. "It's a nightmare," she says.

That nightmare scenario is the infamous Amazon tipping point, where the ecosystem can no longer cope with the damage being inflicted and irreversibly flips into a new stable state. Like a game of Jenga, brick after stabilising brick is removed until the tower collapses in a heap.

Warnings that this is approaching have now taken on extreme urgency. The rate of deforestation has increased sharply and is fast approaching the theoretical limit. In September, the Science Panel for the Amazon (SPA) – a group of more than 200 experts including Gatti – released an assessment of the state of play. The verdict: we are on the edge of disaster.

Scientists first began to seriously worry about a potential Amazon tipping point in about 2000, when modellers at the Met Office Hadley Centre in the UK warned that a combination of climate change and deforestation could cause the rainforest to dry out.

A few years later, a team of Brazilian scientists including Carlos Nobre, who is now co-chair of the SPA, put numbers on it. Their model estimated that in central, southern and eastern parts of the Amazon, a loss of 40 per cent of forest cover from pre-industrial levels – or 3°C of warming – would reduce rainfall so much that the rest of the forest would die of thirst and turn into savannah in less than a decade. They dubbed this irreversible process "savannisation".

Nobre has since revised that threshold down, partly to factor in the global warming that has happened since 2000. The Amazon is already 1.2°C warmer than it was in pre-industrial times and is warming three times

faster than the global average. At that level of warming, between 20 and 25 per cent deforestation would deliver the coup de grace.

Either way, we would be wise not to exceed 20 per cent, says Nobre, "for the common-sense reason that there is no point in discovering the precise tipping point by tipping it".

That magic number is fast approaching. The SPA says that 17 per cent has already been lost and a further 17 per cent degraded. According to Tasso Azevedo, part of the MapBiomas project, which has been monitoring land-use change across the Amazon since 1985, at current rates of deforestation we will hit 20 per cent overall by the end of this decade. In Brazil, the number is already 19 per cent. And a report earlier this month put deforestation in Brazil's Amazon to be at the highest levels in 15 years.

The key to understanding the game of Amazon Jenga is the interaction between trees and water. "It's all about what trees and leaves do, which is to promote the evaporation of water," says SPA member Thomas Lovejoy at George Mason University in Fairfax, Virginia. "They are very powerful movers of water."

In an intact Amazon, water vapour blowing in from the Atlantic Ocean on the prevailing easterly winds joins an atmosphere already laden with moisture. About a third of it is there because of evapotranspiration: trees siphoning water out of the soil and releasing it into the air from their leaves. The air periodically becomes saturated, the moisture falls as rain, and the cycle starts over. This hydrological cycle is central to the health of the Amazon ecosystem,

says Nobre. Not only does it keep the forest wet and the rivers full, it also has a cooling effect.

As tree cover is lost to cattle ranching, soya bean plantations, mines, roads, urban sprawl and wildfires, however, the hydrological cycle is enfeebled. The remaining forest begins to dry out and, as evapotranspiration declines, temperatures rise. Trees stressed by drought and heat reduce their rate of photosynthesis and stop absorbing CO₂. Their leaves turn brown and fall off; entire trees die. The resulting leaf litter and wood decomposes and emits CO₂. It also dries out and becomes a tinder box. Fires are started deliberately or break out naturally, destroying yet more cover. "It's a domino effect," says Nobre.

This cycle is especially vicious in the dry season. In the southern Amazon, natural annual climate oscillations create a relatively dry period from September to November. An intact forest is wet enough to ride out the dry season or a drought, but where trees are already stressed, the extra dryness and heat can be lethal. The dry season is also lengthening because of the disruption of the hydrological cycle, exposing vulnerable trees to more sustained stress. Yet another Jenga piece is lost.

Parts of the Amazon are already showing signs of a severely disrupted hydrological cycle, says Nobre. "The dry season in the southern Amazon is three to four weeks longer than in the 1990s, two to three degrees warmer and 20 to 30 per cent drier," he says. This combination of warming, drought and forest degradation has led to a severe increase in vulnerability to fires, he says.

There are other warning lights flashing. Severe droughts used to strike about once every 20 years. They are now a twice-a-decade phenomenon, with droughts in 2005, 2010, 2015-16 and 2020. Across the Amazon, the mortality rate of tree species adapted to a wet environment is increasing, a sign that they are being pushed beyond their natural biological limits. In the central Amazon, repeatedly burned areas of forest are failing to regenerate and are turning into sandy savannah. Meanwhile, "animal species typical of the savannah are starting to move into the southern portion of the Amazon", says Nobre. Savannisation is under way.

The most ominous warning yet was delivered earlier this year. A team led by Gatti spent nine years flying small planes over four regions of the Amazon – the north-east, south-east, north-west central and south-west

“The Amazon is warming three times faster than the global average”

“The south-east of the Amazon has flipped from being a carbon sink to a carbon source”

central – taking samples of the air and monitoring the temperature, the moisture content of the soil, how much had been burned and the greenness of the canopy.

Over the course of the study, which ran from 2010 to 2018, they saw some dramatic shifts. “The rainfall has reduced a lot, the temperature has grown a lot, and the forest felt it,” says Gatti.

Fatal blow

The hardest-hit areas were in the east. By 2018, the north-east study area was 37 per cent deforested and the south-east 28 per cent. Over the nine years, dry-season rainfall fell by 20 to 30 per cent and the average dry-season temperature rose about 2°C. In the south-east, in particular, where there is an “arc of deforestation” because of encroaching cattle and soya, this is delivering a fatal blow to the forest. “The forest is now more dying than growing,” says Gatti. As a result, the south-east has flipped from being a carbon sink to a carbon source. Rather than soaking up some of our emissions, it is adding to them.

“This is the most troubling element,” says Nobre. And the situation is getting worse. According to Gatti, in the 50 years up to 2018, the Amazon lost about 17 per cent of its forest cover. In the past three years, the rate of deforestation has accelerated dramatically and a further 1.5 per cent is being destroyed a year. Parts of the east are now 40 per cent farmland and she says she wouldn’t be surprised to see 50 per cent. “This is amazing, crazy deforestation,” she says.

Given the levels of deforestation in the southern Amazon, it isn’t unreasonable to argue that these changes signal that, in this region at least, the point of no return is approaching. “Putting all these things together we can say we are very, very, very close to this tipping point,” says Nobre. “Some scientists believe the tipping point may have already been exceeded in portions of the Amazon.”

Lovejoy shares the sentiment. “We’re seeing the ecological system of South America begin to come apart,” he says.

What would that mean? According to Nobre, once the threshold is exceeded, the forest will degrade further even without any more active deforestation. Eventually, over the course of years or decades, up to 70 per cent of the Amazon rainforest will flip to dry savannah. Not everything will go. “We are only going to

have remaining forest near the Andes where the concave shape of the Andes makes for very high levels of rainfall,” says Nobre.

But that won’t save the Amazon, and indeed the rest of the world, from disaster.

The Amazon covers an area of about 5.5 million square kilometres, more than 20 times the area of the UK, and holds around 10 per cent of the world’s species, a quarter of them found nowhere else. It is a hotbed of cultural diversity, with 30 million people from more than 350 ethnic groups. It also supplies the world with a vital ecosystem service in the form of carbon sequestration. According to Gatti, the forest stores at least 100 billion tonnes of carbon above and below ground.

The loss of 70 per cent of the Amazon will deposit more than 50 billion tonnes of that stored carbon into the atmosphere, according to Nobre – equivalent to roughly six years of global carbon emissions from the burning of fossil fuels and a tenth of what we can still afford to emit from now on to give ourselves a 50:50 chance of staying within 1.5°C of warming. That would make reaching the Paris Agreement target of no more than 1.5°C of warming almost impossible, says Nobre.

“If we lose the Amazon, the global temperature can grow 0.25 degrees,” says

People working for a logging company in the city of Portel in the Brazilian Amazon



Azevedo. That would be bad enough, but the added fear is that it could push the climate past one or more other potential tipping points, such as the thawing of the Arctic permafrost or the loss of an Antarctic ice sheet.

“These things are very dangerous because they can create a cascading effect that will impact the whole basis of the biosphere,” says Robert Nasi, director-general of the Center for International Forestry Research in Indonesia.

At the very least, the loss of a major chunk of the Amazon could do irreparable harm to neighbouring ecosystems of international importance, including the high Andes and the tropical savannah of the Cerrado.

Amid all this gloom, however, are reasons for hope. Paulo Brando at the University of California, Irvine, points out that the 20 to 25 per cent figure comes from computer models that are inherently uncertain. One especially thorny factor is rising levels of CO₂, which boosts the growth of vegetation and may offset the deforestation somewhat. Models that leave this out produce tipping points at 20 to 25 per cent, but throw it in and you suddenly get a wider range of outcomes.

The claim that the tipping point lies somewhere between 20 and 25 per cent thus remains a hypothesis, says Brando – albeit a plausible and scary one. “If it’s supported by observation, we are in huge trouble,” he says. “The changes that we’re seeing today are in agreement with predictions. But to jump from there and say that we have initiated this snowball effect that would lead to savannisation of the Amazon, there are large uncertainties.” Nonetheless, he still supports urgent action. “The tipping point is something that we don’t want to find out by doing.”

Some scientists are wary of crying “tipping point” at all. “I think we in general have to be careful about throwing that phrase around, it’s kind of dangerous,” says Scott Denning, an atmospheric scientist at Colorado State University who wrote a commentary on Gatti’s research in *Nature*. In the context of the Amazon, it wrongly suggests that the entire forest is doomed, he says. He does accept that the south-east region has crossed a dangerous threshold where it no longer helps to soak up our carbon emissions. But that isn’t the same as total collapse.

The Amazon also emits a lot of the potent greenhouse gas methane, mostly from its



VICTORMORIYAMA



PARALAXIS/SHUTTERSTOCK

Cattle ranching (above) and soya plantations (below) are drivers of deforestation in the Amazon

wetlands. It isn't clear what would happen to this under savannisation, but it is reasonable to assume that levels would fall.

Window of opportunity

Even if we are approaching a tipping point, it isn't too late. "There is a narrow window of opportunity to change this trajectory. But action must be exponential," says Mercedes Bustamante at the University of Brasilia, who is a member of the SPA.

Many other scientists express similar sentiments. But if the worst is to be avoided, the rescue plan must be swift and decisive. The absolute priority is to restore the hydrological cycle, says Lovejoy, by stopping further degradation and replanting trees.

The minimum requirement for that is an immediate halt to deforestation, says Nobre, followed by a huge reforestation effort. In some places, that means tree planting, in others passive rewilding. "When forests are degraded, they are not gone," says Brando.

"They have an amazing ability to bounce back."

Similar efforts to regenerate Brazil's Atlantic Forest – which is separate from the Amazon – are proving unexpectedly successful. Regrown forest isn't quite as biologically rich as virgin rainforest, but it can still hold 70 to 80 per cent of the carbon and 65 per cent of the biodiversity of a primary forest, says Nobre.

Another minimum requirement is law enforcement, says Bustamante. "Amazon countries have good environmental laws but they need to enforce them." Brazilian law allows no more than 20 per cent deforestation of a given area, says Gatti, but as her research has found, this is routinely flouted. About 10 per cent of deforestation is illegal, often aided and abetted by corrupt regional politicians, says Rodrigo Botero García at the Foundation for Conservation and Sustainable Development in Colombia.

If the situation is stabilised, next comes the long, hard slog of building a new Amazon economy based on agroforestry, which means rearing livestock and growing high-value crops

such as cacao under the canopy of a secondary forest – one that has regrown after tree loss. That has the added advantage of benefiting the locals, including Indigenous people, rather than multinational agribusiness companies. "Most of the profits from the existing Amazon economy leaves the Amazon," says Nobre.

The ranchers, soya bean farmers and even Brazil's deforestation-denying president Jair Bolsonaro seem to be waking up to the situation. Beef and soya farmers, who Nobre says are collectively responsible for 90 per cent of Amazon deforestation, have already noticed that disrupting the hydrological cycle isn't a sensible long-term strategy. "Agribusiness is already starting to have big economic problems with reduction in precipitation and drought," says Gatti.

The big companies are also responding to international pressure, says Brando. Many have spent years building the trust of buyers and the confidence of consumers and don't want their reputations trashed along with the forest. At COP26 in November, Brazil signed the Glasgow Leaders' Declaration on Forests and Land Use, which commits signatories to end deforestation by 2030. "We are happy that Brazil signed the forest pledge," says Ane Alencar, science director at IPAM Amazonia in Brasilia. "I want to believe, but we want to see more concrete steps, we want to see a very detailed plan. We need to demonstrate as a country that we can reduce deforestation." Brazil already appears to be backtracking on its pledge by claiming, erroneously, that it only applies to illegal deforestation, says Alencar.

And even if Brazil does end deforestation by 2030 the forest is so degraded in places that it will continue to emit CO₂ for many years, says Paulo Netto at the University of Sao Paulo. From scientists and activists alike, the message comes across loud and clear: the Amazon is in serious trouble and accelerating towards the brink, but where there is life there is hope. "We cannot be the prophets of doom. We have a moral obligation to remain optimistic and to try to do something," says Nasi. "The future is not written, the future is what we do." ■



Graham Lawton is a staff writer at *New Scientist* and author of *This Book Could Save Your Life*. You can follow him @grahamlawton

How to be more rational

To explain the paradox of why a smart species embraces so much codswallop, we need to rethink rationality, as **Steven Pinker** tells *New Scientist*

HUMANITY faces some huge challenges, from the coronavirus pandemic and climate change to fundamentalism, inequality, racism and war. Now, more than ever, we need to think clearly to come up with solutions. But instead, conspiracy theories abound, fake news is in vogue and belief in the paranormal is as strong as ever. It seems that we are suffering from a collective failure of rationality.

Steven Pinker doesn't buy into this disheartening conclusion. In his new book, *Rationality: What it is, why it seems scarce, why it matters*, the Harvard University psychologist challenges the orthodoxy that sees *Homo sapiens* as a species stuck in the past, with an ancient brain fuelled by biases, fallacies and illusions, incapable of understanding the complexities of the modern world.

History, he argues, refutes that. After all, humans have built civilisations, discovered the laws of nature, vanquished diseases and identified the building blocks of rationality itself. Ours isn't an innately irrational species, says Pinker. However, we don't embrace our

rational side as much as we might. With more insight into the human mind, we can learn to change that – and master an underused resource that will help us tackle the challenges of the 21st century and beyond.

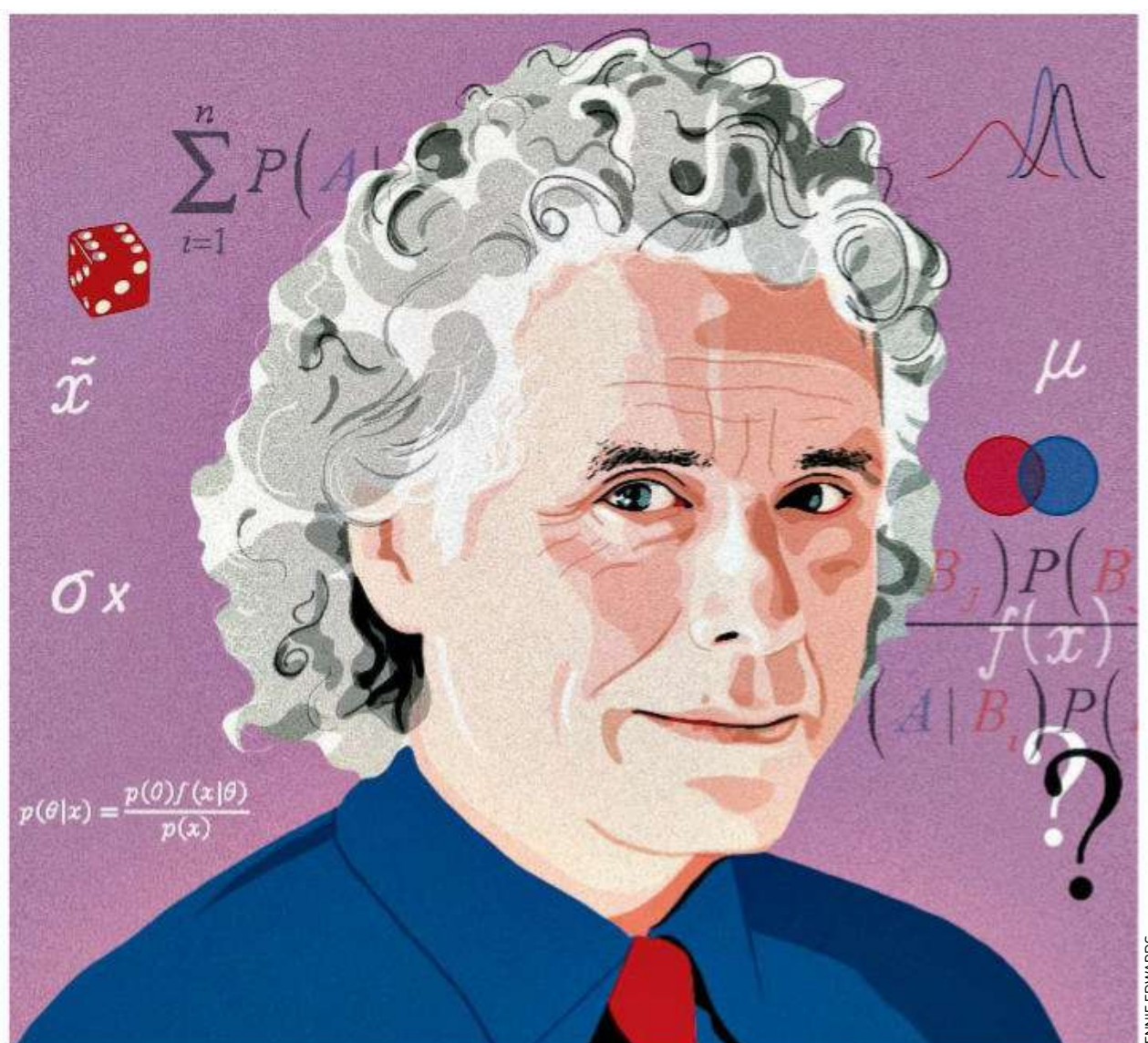
New Scientist: What do you mean by rationality?

Steven Pinker: I define it as the use of knowledge to attain goals. There is not one single tool of rationality – it depends what you're after. If you're seeking to derive new true statements from existing ones, then logic is your tool. If you want to assess your degree of belief in a hypothesis based on evidence, then Bayesian reasoning. If you want to figure out what's the rational thing to do when the outcome depends on what other rational people do, game theory.

Those tools don't seem to come naturally to people, yet you reject the idea that human cognition is a heffalump trap of biases and delusions that are a legacy of our evolution. Why? Yeah, I don't think it's quite right. Although there's no question we do have outbursts of irrationality – and they are all too plentiful –

I'm not ready to write off our species as irrational. We can all be rational when it comes to our immediate surroundings and outcomes that affect our lives. And if you're upset about some outbursts of irrationality, don't blame hunter-gatherers. I begin the book with a description of how the San people of the Kalahari desert deploy rationality to engage in pursuit hunting, where they've got to figure out where the antelope may have run based on some fragmentary tracks on the ground. They engage in some pretty sophisticated inference. They wouldn't survive if they didn't.

All of us command some aspect of rationality. In our everyday lives we package it with subject-matter knowledge in particular areas – bringing up the kids, holding down a job, getting food in the fridge. What we don't wield are tools that can be applied to any subject matter: calculating probability, distinguishing correlation from causation, Bayesian reasoning, statistical decision theory. Those come less naturally to us. And when it comes to issues that are larger than our day-to-day physical existence, people don't necessarily hew to the mindset



that ideas should be evaluated as to whether they're true or false.

You also claim that some seeming irrationality can be understood as the rational pursuit of goals. How so?

Rationality always has to be defined with respect to a goal. What are you deploying your thought processes to attain? The goals sometimes can be dubious, but you can be extremely methodical at attaining them. I cite the defenders of Donald Trump against accusations of irrationality, who will say: Well, he got to be president, didn't he? If the goal is glorifying Donald Trump, rallying his supporters and gaining the levers of power, he was quite a genius at it. From the point of view of his own rationality, there was a certain cunning.

But surely the current "pandemic of poppycock", as you call it, is something new?

Conspiracy theories are probably as old as human groups. Paranormal woo isn't new. Neither is fake news. These are maybe the default mode of our species. For most of

human history, it was hard to tell what was true or false. What is the origin of fortune and misfortune? What is the origin of the universe? What actually happens behind closed doors in palaces and halls of power? You can't find out. But there are some beliefs that will rally your coalition together – that are uplifting, that are morally edifying, that are entertaining – and those stories for most of our history were as close as we could get to the truth, and they served as a substitute for the truth.

What's unusual now is that we have a lot of means to answer questions that formerly were just cosmic mysteries. Before that, it was a matter of conjecture. And a good story was the best we could do. We carry over that mindset when it comes to the cosmic, the counterfactual, the metaphysical, the highly politicised.

You describe key mechanisms through which people form irrational beliefs – the three M's of motivated reasoning, myside bias and mythological belief. Can you unpack them one at a time?

Motivated reasoning is a phenomenon where we direct our reasoning toward something

that we want to believe in the first place. There is a saying from the [late] American journalist Upton Sinclair that it's very hard to get a man to understand something when his livelihood depends on not understanding it. In the lab, we see this manifested when you give people a logical syllogism [two statements with a logical conclusion] and ask them if the conclusion follows from the premises. If the conclusion is something that they want to be true, they are apt to ratify an invalid syllogism – and vice versa if it is a conclusion that they don't want to be true.

And myside bias?

Motivated reasoning can be in the service not just of a goal that favours the individual, but often the larger coalition that he or she belongs to, in which case it's called the myside bias. Namely, you direct your reasoning to end up with a conclusion that is already a belief in your team, your coalition, your party. It's among the most powerful of the many cognitive biases that have been documented by cognitive psychology. It afflicts the [political] left and the right. Being smart ➤



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does not make you immune to it. And it's rather hard to unlearn.

There is a variety of ways in which we comfort ourselves in thinking that beliefs of our side are valid and wise. We muster our ingenuity, we take advantage of ambiguities in the evidence, we feed ourselves evidence that supports our position and try to ignore sources that might contradict our preferred beliefs. We think more like lawyers than scientists.

What are some real-world manifestations of myside bias?

With politicised issues in science such as anthropogenic climate change, scientists are often surprised that there is so much denial. They sometimes attribute it to scientific ignorance or illiteracy. But that is a less-than-rational belief because it's not

based on empirical studies of why people deny climate change. What those studies show is that the deniers are actually no more ignorant of science than the believers. In fact, a lot of people who endorse the scientific consensus are really out to lunch when it comes to the science of climate change. They think it has something to do with the ozone hole, toxic waste dumps, plastic straws in the ocean. What does predict people's belief in climate change is their politics. The farther you are to the right, the more denial there is.

That's a case in which the scientifically respectable conclusion is aligned with the left. But there are also cases where the left is out of touch with the scientific facts.

My claim that left and right are equally biased is not just an attempt to be even-handed. Research on the myside bias

shows that both the left and the right are susceptible. A given set of data – say on the efficacy of gun control – will be seen to support or not support a position depending on whether the reasoner belongs to a side that believes it in the first place.

And then we get to the third and most potent M, which is mythological belief.

I think this a powerful explanation for why people apparently believe so much nonsense. There are real beliefs like "I believe there is a beer in the fridge". But then there's a whole family of beliefs that are more like stories that capture a deeper truth: what our enemies are capable of and how dreadful they are; how noble our side is, how wise and pure and good. Whether these things are true is almost beside the point. These are mythological beliefs.

Seven ways to build a more rational world

▶ Rational thinking requires mental tools that don't come naturally. We have an intuitive sense of them, says psychologist Steven Pinker, but to improve our grasp, schools should teach logic and critical thinking, and replace outdated subjects like trigonometry with probability and statistics.

▶ People should also be made aware of the many cognitive biases that influence our thinking. "We are all victims of bias," says Pinker. "But self-awareness of that means that we can interrogate our own unexamined biases."

▶ We should seek to belong to communities in which the

overarching goal is objective truth. The aim here is to submit to the pains of peer review, of having your ideas challenged and of having to defend your beliefs.

▶ Resisting irrationality isn't simply down to individuals, it also rests on social institutions with norms and rules that allow us to be collectively more rational. Functioning democracy, rigorous journalism and depoliticised universities are three cornerstones.

▶ Our legislatures are often dominated by lawyers whose professional goal is victory rather than truth. If there were more scientists in politics, they could

try to spread the value of evidence-based problem-solving among their colleagues, says Pinker.

▶ "But there's a danger of scientists presenting themselves as a kind of priesthood," he adds. When debates are shut down and holders of unpopular beliefs cancelled, that sends the wrong message. Science must show that it is an arena where truths can emerge.

▶ Finally, we can all help make rationality a social norm. By deriding irrational thinking and championing behaviours such as acknowledging uncertainty, questioning dogmas and changing our minds when the facts change, rationality becomes cool.

Some of our national founding myths may fall into that category. Some religious beliefs too, and believers are sometimes offended by the idea that they should be subject to empirical scrutiny. For them, belief in God is a kind of belief you hold for its moral benefits, not for its factual accuracy. It's a different kind of belief.

I quote Bertrand Russell, who said it is undesirable to believe a proposition when there are no grounds whatsoever for believing it is true. And what I note is that this is at odds with the way that most people think. It's a product of the Enlightenment that we think that every question ought to be put in the realm of reality and tested for its literal veracity.

That seems to imply that some beliefs are beyond criticism and impervious to evidence. Is that right?

There is a tendency to protect these beliefs or at least to take them out of the realm of evidence, but the boundary between the real and the mythical can be changed. The origin of fortune and misfortune may once have been attributed to fate, but we now consider it an empirical question. We want to know what gives you Alzheimer's. It's not divine retribution.

I think the general tendency since the Enlightenment has been to try to bite off chunks of the mythology zone for the reality zone. I say the more the better, and in particular areas, we can try to persuade people that, no, you can't just believe anything you want. There really is a fact of the matter.

Can that boundary between reality and mythology shift in real time, say with something like covid-19 that starts as an abstract threat, but then becomes horribly real?

You would think that vaccine hesitancy would crumble in the face of covid. It has not, although it has declined. What I suspect happens is that with any mythological belief, there are the true believers who will go to their graves believing, no matter how high the evidence piles up. But there are always some who are more open to the evidence.



KARIN DUTHE/LAMY

The San people of the Kalahari use rationality for pursuit hunting

"Conspiracy theories, paranormal views and fake news are not new – they may be the default mode of our species"

An anti-vaccination protest in London, earlier this year



VUK VALCIC/SOPA IMAGES/SHUTTERSTOCK

Yet it seems that the mythological zone is expanding right now, at least in Western democracies. Is it?

It's all too easy to come to a conclusion based on our own availability biases, and on an understanding of the world from anecdotes, which is basically what journalism consists of. Unfortunately, we don't have the good evidence over an extended period that would settle it. I cite a study that looked for conspiratorial content in letters to the editors of major American newspapers over a span of more than a century and found no increase. The data I found on belief in paranormal phenomena among Americans – astrology, crystal power, haunted houses – is pretty much flat over 50 years, too.

So humanity isn't losing its mind today any more than it has in the past?

No. But we are squandering some of the tools that could make us more rational if they were more widely applied. It's not that people are saying more unfounded or outlandish things, but we're more cognisant of the higher standards that we ought to apply, and so the lapses are all the more salient to us. In terms of the moral statement of what we ought to do, it's now accepted that we ought to prioritise rationality. ■

Interview by Graham Lawton, a staff writer at *New Scientist*

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The science of cooking

Home sweet home

'Tis the season to erect beautiful gingerbread houses, but make sure your building materials are fit for purpose, says **Sam Wong**



Sam Wong is social media editor and self-appointed chief gourmand at New Scientist. Follow him @samwong1

Ingredients

For the biscuit:

200g butter

200g brown sugar

7 tbsp golden syrup

600g plain flour

3 tsp ground ginger

3 tsp ground cinnamon

Half tsp ground cloves

For the icing:

2 egg whites

500g icing sugar

Hard sweets for windows

More sweets for decorating

CREATING a gingerbread house is a fun festive activity, but shoddy construction can spoil the party and put any gingerbread inhabitants in serious danger. This recipe and some tips will help you avoid catastrophe.

First, create a design. It is helpful to draw the pieces for your house on paper, then cut these shapes out to use as templates. The quantities of ingredients listed will give you enough gingerbread to make a structure 30 centimetres tall with walls 20 cms wide.

Building requires a strong and stable biscuit. A dense dough with a low moisture content is ideal, so that the pieces stay flat. This means no eggs or raising agents. A high flour-to-fat ratio also makes for a tougher biscuit: proteins in flour form a gluten network that provides strength and elasticity to help the pieces resist deformation.

Melt the butter, sugar and syrup in a saucepan. Mix the flour and spices in a large bowl, then stir it into the butter mixture. If necessary, add a splash of water to help the dough come together.

Roll out your dough on a sheet of baking paper the size of your baking tray and cut the pieces guided by your paper templates. Ensure the pieces share edges wherever possible to make the most of the space on the tray. The dough will tend to expand when baking, so it is a good idea to leave some excess dough in place around the edges of outer pieces, to help them maintain their shape.

Bake the biscuits at 200°C for 12 to 15 minutes, until they start to



STOCKFOOD/JONES, HUY

darken at the edges. On removing from the oven, immediately recut the pieces before they harden.

For an impressive decorative feature, create window holes in the gingerbread, place crushed boiled sweets in the windows and put the pieces back into the oven for about 5 minutes to melt the sweets and form colourful glazed windows. If you have a small light that will fit inside the house, they will look truly spectacular.

You will need something to bond your pieces together. Some websites recommend melted marshmallows and gummy bears, but I found these much too sticky and tricky to work with. Royal icing is easier, looks better and has plenty of strength. It contains protein-rich egg whites. These proteins denature and coagulate

when beaten, making the icing hard when it dries. Mix the beaten egg whites with half the icing sugar, then slowly mix in the rest.

Use a piping bag to apply the icing to the edges of the pieces and wherever else it is needed. Stick the base of the walls to the board you are building on. To keep the roof panels from sliding down before the icing dries, first stick a big square of baking paper to the underside of the two panels with icing, so they are held together by the paper. Then stick the roof on.

Have fun decorating the house. The low moisture and high sugar content means the biscuits should be good to eat for about a week. ■

The science of cooking appears every four weeks

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'The Robots are ready. All they need now is a brain'
New Scientist 2 February 2019

This new book answers that challenge
Here is a brain for a robot. This brain is not a computer program but a collection of networked associations that allows it to have free will, learn language, plan, use working memory, and possibly show conscious awareness.

AN AGI BRAIN FOR A ROBOT

John H Andreae

AP

An AGI Brain for a Robot by John H Andreae describes the PP brain controlling a robot body and learning from a second robot under human control in a simulated world.

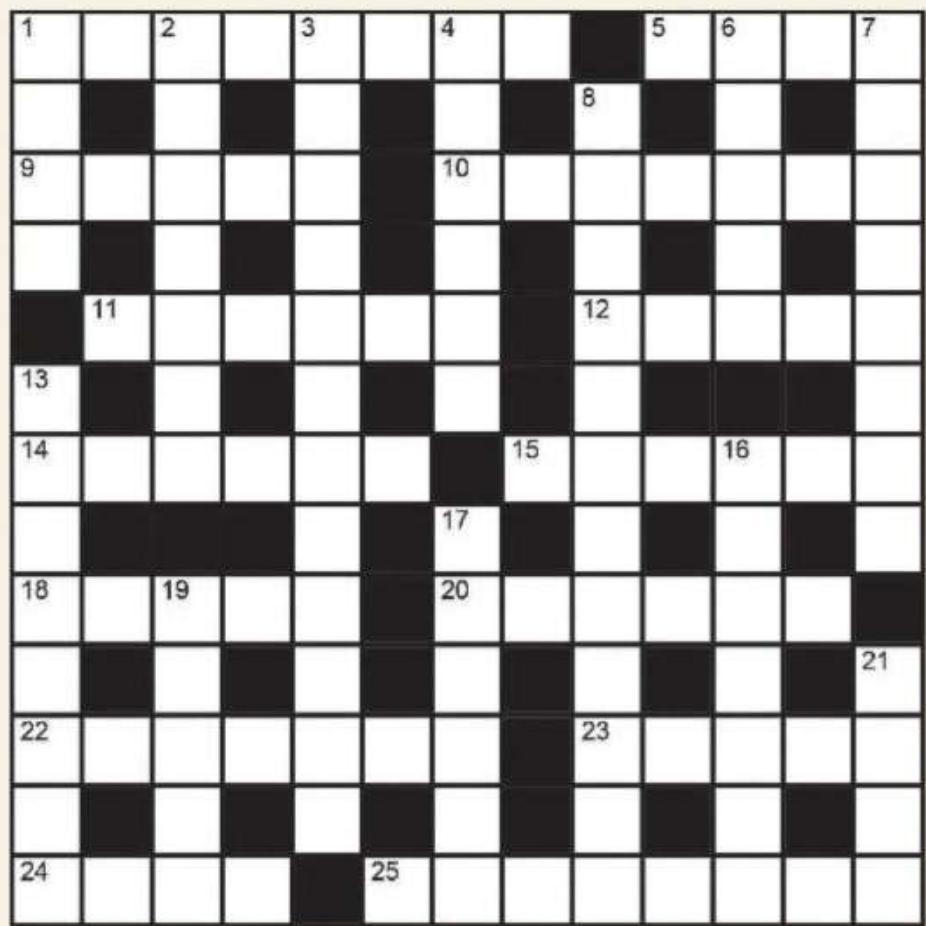
An Artificial General Intelligence (AGI) that works like our own human brain is within our grasp.

This book is for neuroscientists, robot designers, psychologists, philosophers and anyone curious about the evolution of the human brain and its specialised functions.

'A little book that punches far beyond its weight'
Nicholas Humphrey

Read up to page 10 and see reviews on Amazon

Cryptic crossword #72 *Set by Rasa*



Scribble zone

Answers and our giant festive cryptic crossword next week

ACROSS

- 1 Tap police merchandise for Spooner (8)
- 5 Clean antimony-coated tungsten article (4)
- 9 Constant buzzing accompanies a delivery order (5)
- 10 Discussed parody involving half-finished kegs (5,2)
- 11 Observe the stew (6)
- 12 Eagerly take in retrospective of immature stage (5)
- 14 Come back with glassware (6)
- 15 Enzyme, by the way, is absorbed by shredded pine (6)
- 18 Rope material damaged sails (5)
- 20 Otherwise, Dr Luke kept quiet in the chat room (6)
- 22 Animal lab output one mutant cell (7)
- 23 Pits heavy for their size, reportedly (5)
- 24 Blue feathers (4)
- 25 Instrument producing an eerie sound in that location, at least (8)

DOWN

- 1 Backed up hot tubs' drains (4)
- 2 Runniest two eggs I covered with lemon rind (7)
- 3 Mushrooms that woman from Provence fed to Benedictine monks, say (1 2)
- 4 Tropical tree funds we raised (6)
- 6 With assistance, produce puppies (5)
- 7 Perplexing double failure interrupting paper bundling (8)
- 8 Preload expanding speed gun technology (7,5)
- 13 Desired converts after Page led the meeting (8)
- 16 Mobster numbly buries bone (7)
- 17 Organism studied by Darwin eats large quail (6)
- 19 Stitch holds in tendon (5)
- 21 Bins wrong book ID (4)

Quick quiz #131

- 1 Astronomical objects with a known luminosity that can be used to calculate galactic distances are called what?
- 2 The name of which genus of dinosaurs roughly translates as "swift seizer"?
- 3 Name the country that contains more glacial ice than any other nation outside the polar regions.
- 4 How many chemical elements make up the lanthanide series, including lanthanum itself?
- 5 What did Arno Penzias and Robert Wilson accidentally detect in 1964?

Answers on page 55

Puzzle

set by Chris Maslanka
#143 X marks the Spot

Now that poor Spot has gone to that great kennel in the sky, I have decided to bury him under a new square patio, using square tiles that are all the same size. The tiles along the two diagonals are to be black to form an X that marks his final resting place, and the rest of the tiles will be white.

I went to the builders' merchant to buy the tiles, but when I arrived I had forgotten how many white tiles I needed. Was it 691? Or 916? Or something else? All I knew for sure was that the number of white tiles was a permutation of the three digits 1, 6 and 9.

I couldn't even remember if the whole patio needed an even or an odd number of tiles. How many white tiles did I need? And how many black?

Solution next week



Our crosswords are now solvable online
newscientist.com/crosswords

Buzz off

From a human perspective, mosquitoes don't have many positives. What would be the ecological consequences if they were eradicated?

Jane Monroe

Arcata, California, US

Mosquitoes are a major food source for many bird and bat species, and larval mosquitoes are regularly eaten by various freshwater fish and aquatic insects such as backswimmers, larval dragonflies and diving beetles.

These mosquito consumers in turn provide food and other resources for other organisms. Bats, for example, play a critical role in the health of cave ecosystems; they also consume, and help control, many agricultural pests.

The eradication of mosquitoes might please humans in the short term, but would eventually damage many ecosystems due to a cascade of negative consequences as more and more species were

“The eradication of mosquitoes might please humans in the short term, but would eventually damage many ecosystems”

affected. A better plan might be to eradicate the disease-causing parasites that use mosquitoes as a vector.

Jonathan Wallace

Newcastle upon Tyne, UK

This is a variant of the “what is the point of...?” question that often gets posed about species we consider to be pests.

The eradication of mosquitoes would certainly have consequences. Firstly, there is the question of how the mosquitoes would be eradicated. Spraying pesticides is the most common method, and it is inevitable that non-target species are also affected.



DEEPLY PLAINPICTURE/FREDERIC CROU

This week's new questions

Rousing stuff Why does stretching and yawning after waking up feel so pleasant and what are the benefits? **Ashley la Grange**, Watford, Hertfordshire, UK

Impending doom Do any animals, other than us, have an awareness of their own mortality? **Stefan Slater**, Tideswell, Derbyshire, UK

The second question is what effect would the absence of mosquitoes have? Although we are mainly familiar with the bloodsucking habits of mosquitoes, their principal food source is flower nectar. Blood is only consumed by females to provide the additional protein required for egg production. Through their flower visiting, they are part of the overall guild of insects that act as pollinators.

Another potential impact of mosquito eradication is on the behaviour of other species. In places with many flying biting insects, cattle, horses and other large grazers spend parts of the day resting in dusty, vegetation-free areas that are exposed to the wind, as a means of gaining respite from the insects.

It is possible that wiping out the biting flies could remove a behavioural constraint on these herbivores that would enable them to graze for longer in areas that are currently only tolerable for short periods of time due to the fly density. Who knows what impact this might have on the vegetation?

Eric Kvaalen

Les Essarts-le-Roi, France

A 2010 article entitled “Ecology: A world without mosquitoes”, in the journal *Nature*, discussed the idea of totally eradicating mosquitoes. It concluded: “Ultimately, there seem to be few things that mosquitoes do that other organisms can't do just as well – except perhaps for one. They are lethally efficient at sucking

Cats, dogs and humans all instinctively stretch and yawn after waking, but why?

blood from one individual and mainlining it into another, providing an ideal route for the spread of pathogenic microbes.”

Double dipper

The constellations are pictures we perceive by “connecting the dots” of random stars, but it seems incredible that we have two dippers in the night sky with similar shapes and proportions. Is this just a coincidence or is there an explanation?

Garry Trethewey

Cherryville, South Australia

The explanation isn't in the sky, it is in our pattern recognition. Our brains actively connect the dots and exclude other dots to produce shapes that are meaningful to us.

I am sure that any random spatter of variable dots could produce a group that looks like a dipper: four dots that look vaguely square with a line emerging from a corner. If you preferred pentagons or triangles, you would find them too.

Hillary Shaw

Newport, Shropshire, UK

Our ancestors looked at the brightest stars and joined the dots to make objects they were familiar with. A random scatter of points on a surface will almost inevitably lead to several quartets of four in a rough rectangle, with a few more off one corner making a “handle”. Since water is the second most urgent human need after air, our ancestors would be familiar with ladles, or dippers, to lift water, with bent handles for leverage, and saw them in the stars.

Looking at a diagram of the Big Dipper, one can easily make other patterns. For example, join the star Phecda with Alkaid instead of with Megrez and you get a convex wall, or maybe a reclining chair.

Perhaps it is surprising we only have two dippers.



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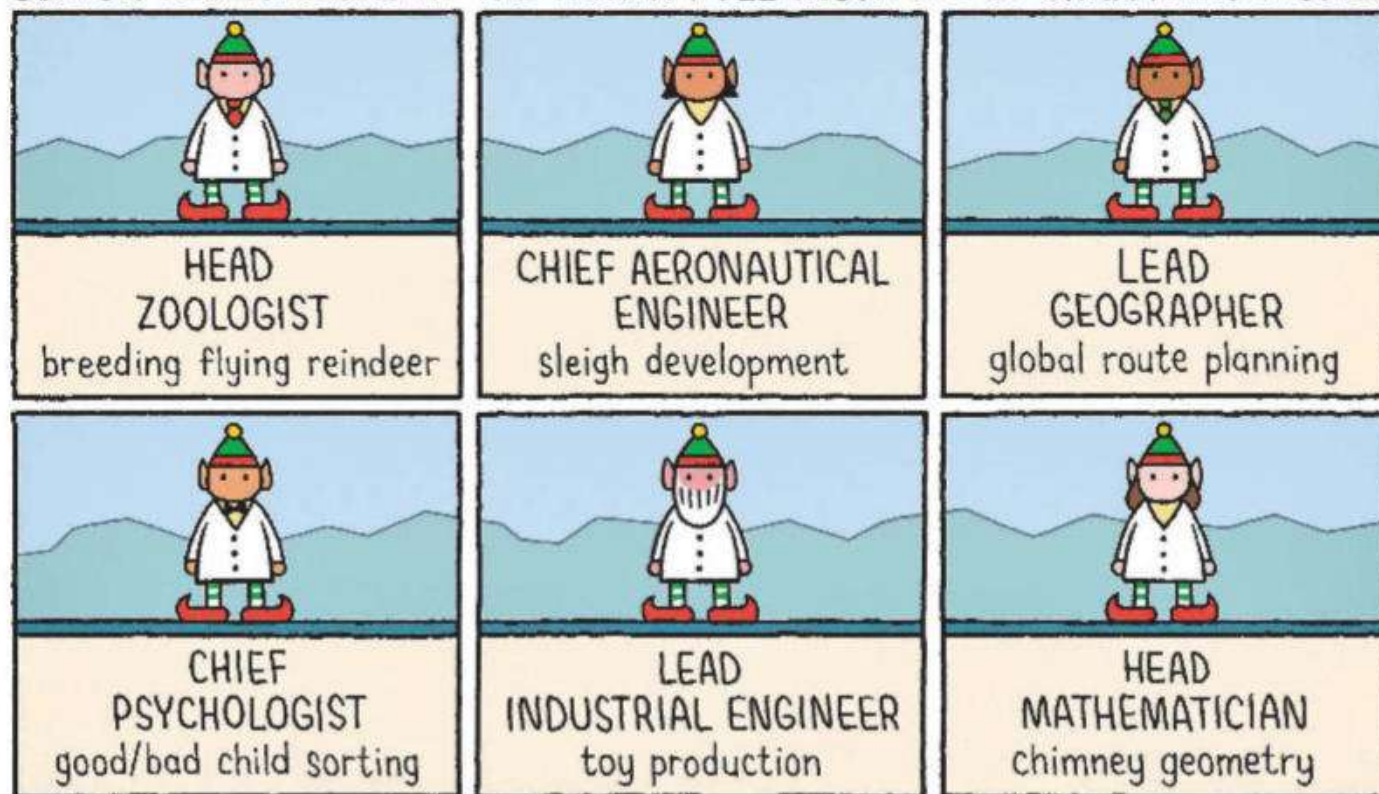
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Tom Gauld
for *New Scientist*

SENIOR RESEARCHERS AT THE NORTH POLE INSTITUTE OF CHRISTMAS STUDIES



Geraint Day

Swindon, Wiltshire, UK

It is almost certainly a coincidence that there are two constellations, parts of which seem to resemble each other, in this case the Big Dipper (part of the constellation of Ursa Major) and the Little Dipper (in Ursa Minor). The resemblance isn't exact though. It is sometimes said that the arrangement of six of the brightest stars in the Pleiades cluster in the constellation Taurus bears a resemblance to the Little Dipper, albeit with smaller angular size than either of the named Dipper patterns.

David Collins

Harpenden, Hertfordshire, UK

Given a clear, dark sky and reasonable eyesight, you can see thousands of stars. They appear at random places with random brightness. If you asked a computer to explore the sky and to look for dippers, allowing for some slight variation in the pattern, you would surely find dozens or even hundreds – large, small, in different orientations.

“If you asked a computer to explore the sky and to look for dippers, you would surely find dozens or even hundreds”

And the same would apply to any other imaginary shape we have imposed on the sky.

Richard Swifte

Darmstadt, Germany

The constellations comprise stars that can be seen easily with the naked eye and that happen to lie in roughly the same line of sight. But the actual distances to these stars can vary a lot, ranging from less than 10 light years to over 100.

If our solar system were in a different location, we would view the stars from a different perspective and our familiar constellations would be replaced by quite different chance groupings. As it is, the stars are moving through space as they orbit around the galactic centre, so their relative positions are

constantly changing. In a few million years, our familiar constellations will most likely have dissipated and been replaced by new ones.

The existence of time

Aside from our perception, how can we know that time exists? (cont'd)

Jonathan Kerr

Ripley, Surrey, UK

To stop the word “time” being ambiguous, the question is better put as: How can we know that motion through time exists?

From relativity (and experiment), we know that two objects that move differently – one shot through space, one left on Earth – have permanent age differences when brought back together. These last billions of years. Even dust grains that move differently for a few seconds do this, throughout the universe, constantly. Because it seems the two objects somehow aged differently, this strongly supports motion through time existing. ■

Answers

Quick quiz #131

Answers

- 1 Standard candles
- 2 Velociraptor
- 3 Pakistan. It has more than 7000 glaciers
- 4 15
- 5 The cosmic microwave background, which is remnant radiation from the big bang

Quick crossword #97

Answers

ACROSS 1 Crossword puzzle, 9 At rest, 10 Essexite, 11 Angstrom, 14 Desert, 17 White cockatoo, 20 Research paper, 23 System, 25 Sciatica, 28 Thinking, 29 Errors, 30 Colorectal polyp

DOWN 2 Retina, 3 Seeds, 4 Water, 5 Rheum, 6 Postdoc, 7 Z-axis, 8 Electrode, 12 Taiga, 13 Oleic, 15 Enter, 16 Parasitic, 17 Wasps, 18 OAPC, 19 Kappa, 21 Rimfire, 22 Scurvy, 24 Tango, 25 Sight, 26 Ideal, 27 Torso

#142 Simultaneous pleasure Solutions

1 The pen is 95p, the pencil 5p. The trap of instinctively answering 90p/10p has become a notorious case study in psychology.

2 Twelve cows, eight chickens.

Ancient aromas

It can sometimes get a little – what’s the word – “close” in Feedback’s stationery cupboard cave. It is to this that we attribute a colleague advancing with pegged nose, thrusting our way on a pair of tongs an advert for the perfume line “Neandertal® for modern human”.

“This pair of fragrances take us on an olfactory journey deep into humanity’s past giving voice to a lost civilisation whose DNA lives on today only through ourselves, while also celebrating the future they were never able to see,” we read among very many other words, not all of which necessarily make much sense to us. “The results are contemporary, highly original, and experimental fragrance structures, free from conventional and traditional perfumery standards.”

“With notes of BO and tooth decay?” a colleague asks, unkindly. Foliage, ginger, pink pepper, grapefruit and pine, apparently.

A temporary blimp

Keith Macpherson from Somerset, UK, reports being informed by DHL of the imminent arrival of a parcel with a weight of 1 kilogram and a volume of 32,884 cubic metres and wondering who ordered a blimp. He later found this corrected to a weight of 1 kg, but a volume of 0 cubic metres, and wondered who had ordered a black hole singularity. “My daughter asked if we had been given a delivery window. My son replied no, an event horizon,” Keith reports – proof that, whatever it was that eventually arrived in Somerset, the dad joke seems safe for another generation.

Gorilla journalism

Many thanks to the many of you who allowed yourselves – and us – a chuckle at an erratum in a recent edition of *The Economist*: “Correction: Last week, in a chart accompanying a piece on nuclear power, we said Britain produced 235 gigatonnes of carbon dioxide

Twisteddoodles for New Scientist



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Consideration of items sent in the post will be delayed

per kilowatt-hour of electricity generated. That should have been 235 grams. We apologise for the rather large error.”

Indeed, fifteen orders of magnitude large. Our schadenfreude is tempered with a healthy dose of “there but for the grace...”. With weary experience, we call into being the journalistic version of the gorilla effect, where you don’t see the big thing because you are too busy concentrating on the small things.

Motions in the dark

Balance being another great journalistic trait, we are compelled to give space to Graeme Flint, who professes no financial interest in the matter, but writes in defence of motion-sensor toilet bowl lights (27 November). He points out that they enable you to do night-time business in low-light conditions

while not activating noisy bathroom fans. “I think they are an energy and sleep saving triumph and more people should give them a try,” he says. Right of reply granted, Graeme – we aren’t entirely convinced, but we are at least going through the motions.

In their element

Ilpo Salonen writes in from Espoo, Finland, deploring the lack in our pages of late of a certain deterministic name phenomenon we shall not name. It being December and the season of goodwill, we hold back from sending the usual cease-and-desist letter. Especially as, by way of compensation for our oversight, Ilpo points us to the existence of a now sadly retired science correspondent at the Finnish Broadcasting Company, Yleisradio Oy, called Maija Typpi.

That’s Mary Nitrogen to her English fans. It is fair to say we are enjoying rolling these departures from Indo-European word roots around our tongue. We also find naming people after chemical elements, rather than the other way round, a fun excursion. Although by no means a unique one, come to think of it. The computer scientist Stephen Wolfram is a reminder of why there is a W in the periodic table, although no element officially beginning with W. We welcome other examples of elementary names from across the globe to enrich our cultural experience.

While we’re there...

The former captain of the Geneva firefighting force was Marc Feuarent (or Captain Strong Fire), there is a BBC wildlife documentary producer called Giles Badger and a 2004 paper in the *IEEE Journal of Oceanic Engineering* was “Structure and mechanics of nonpiscine control surfaces” by Frank E. Fish.

We are mentioning these purely on the principle of not fouling our own nest. Or, as the French say, don’t piscine the...

All aflutter

Moving swiftly onwards, backwards and almost undoubtedly inwards to black holes, Jon Sparks raises suspicions that we are now trying to generate our own column inches with a choice experiential unit. He notes that our colleague Leah Crane, discussing the supermassive black hole at the centre of our galaxy in her Launchpad newsletter, writes “Sagittarius A* is more than 4 million times as massive as the sun. An NBA basketball has a mass of 0.62 kilograms. So if Sagittarius A* had the mass of a basketball, the sun’s mass would be 0.16 milligrams – about the average mass of two eyelashes.”

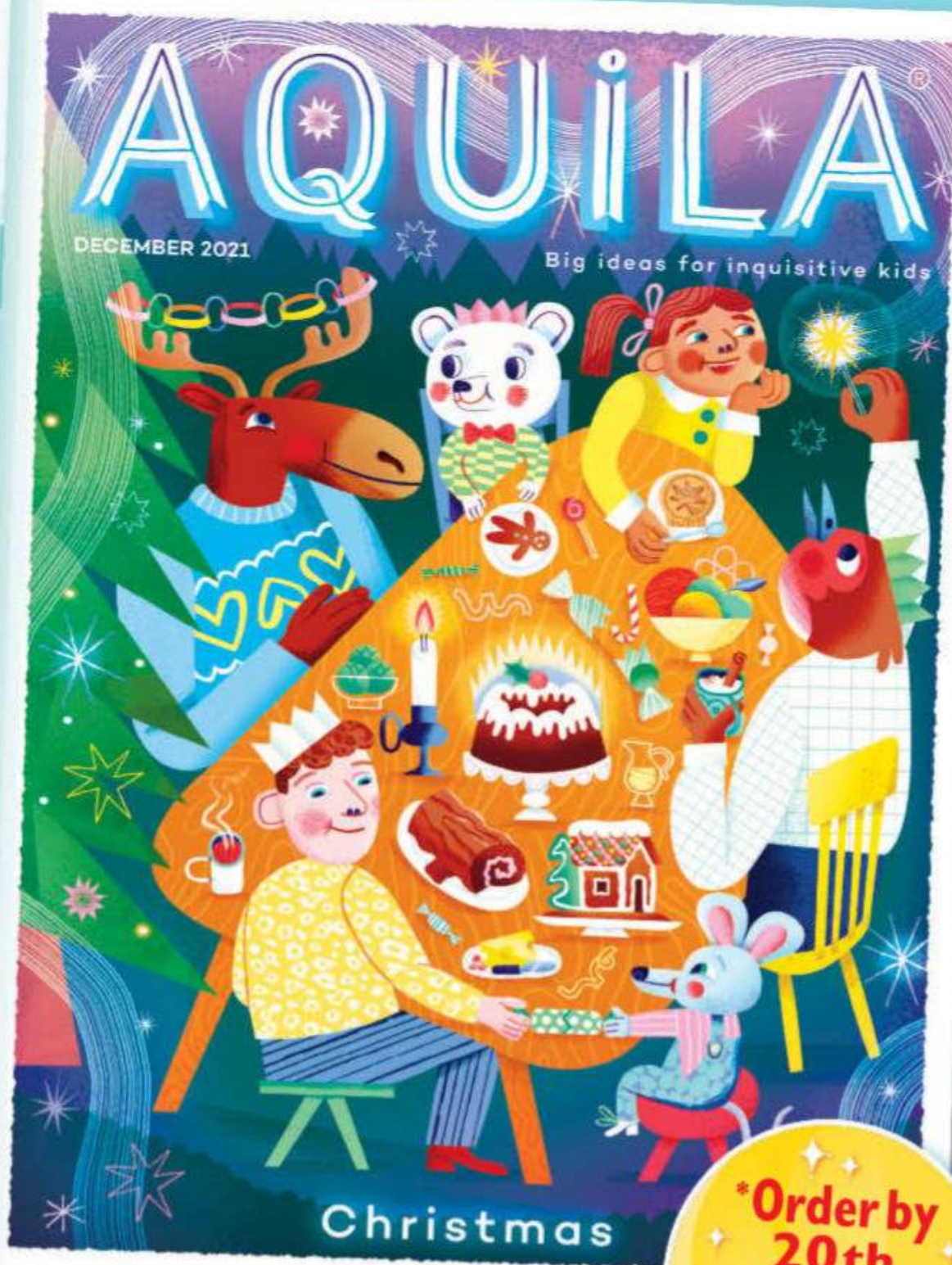
Eye-watering. The thing is, Jon, you might have been wondering about the eyelash thing, but while everyone was distracted by the basketball, a gorilla waltzed across the back of the page. ■

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